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J. W. Hungate.....State Normal School, Cheney, Wash.
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Northwest Scientific Association

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Vice-President....E. C. Johnson, State College of Washington, Pullman, Wash.
Secretary-Treasurer.....J. W. Hungate, State Normal School, Cheney, Wash.

Councilors:

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Thomas Large, The Lewis and Clark High School, Spokane, Wash.
M. F. Angell, University of Idaho, Moscow, Idaho
J. A. Kostalek, University of Idaho, Moscow, Idaho
J. E. Kirkwood, University of Montana, Missoula, Mont.

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FOREWORD

Although the Northwest Scientific Association was organized in April, 1923, and has now held three annual meetings, the plan to publish at least the abstracts of the papers presented at the meetings has not been carried out up to this time. While the officers of the Association are willing to assume a fair share of the responsibility for this delay, it should be understood that delinquency of the members in the payment of dues has been one of the determining factors. It seemed wise to conserve the funds and wait until the Association had grown stronger and made a place for itself. Sometimes it seemed as though the members expected too much from an infant organization, and gave little heed to the earlier efforts of the officers.

In order to satisfy a demand which has been expressed by many of the members, the Council of the Association has decided to start the publication of "Northwest Science" in a modest way, and an effort will be made to continue the numbers, quarterly at first, but with hopes of more frequent appearance and larger size as time progresses. While at first it seems best to devote most of the space to a brief history of the Association and to abstracts of papers presented at the several meetings, it is the plan to include complete addresses or papers just to the extent that space and funds are available. With this declaration of purpose, "Northwest Science" is submitted to the members as a frail child which will require their careful nurture in order that it may grow as the years pass. A small group of enthusiastic officers can not alone maintain the Association but its future in its various undertakings must depend upon the united support of the scientific workers of the Northwest.

It is the hope that "Northwest Science" may grow until it will supply that much needed avenue for the publication of researches which our committee on "Larger Facilities for Research and Publication" had in mind in the report presented to the last meeting. With visions of a Scientific Research Institute for the Inland Empire Country that shall do credit to its potential resources and expanding industrial life, the Northwest Scientific Association will continue to work for the "Promotion of scientific research and the diffusion of scientific knowledge."

Organization of the Northwest Scientific Association

Pursuant to the call of an organization committee consisting of M. F. Angell, University of Idaho, Moscow, Idaho; F. D. Heald, State College of Washington, Pullman, Wash.; Elizabeth L. Martin, State Normal School, Cheney, Wash.; Geo. W. Hess, Whitworth College, Spokane, Wash.; E. B. Harris, Spokane University, Spokane, Wash.; O. C. Pratt, Superintendent of Public Schools, Spokane, Wash.; Thomas Large, Lewis and Clark High School, Spokane, Wash.; and Frederick Keffer, Spokane, Wash., a small but interested group of scientists assembled at the Lewis and Clark High School, Spokane, Washington, at 4:00 p. m., April 6, 1923. The result of this meeting was the organization of the Northwest Scientific Association, and the constitution presented in this report was adopted. The following officers were elected:

President—M. F. Angell, University of Idaho, Moscow, Idaho.

Vice-President—Curtis Merriman, State Normal School, Cheney, Wash.

Secretary—F. D. Heald, State College of Washington, Pullman, Wash.

Treasurer—E. B. Harris, Spokane University, Spokane, Wash.

Councilors—A. L. Melander, State College of Washington, Pullman, Wash.; M. T. Elrod, University of Montana, Missoula, Mont.; H. S. Brode, Whitman College, Walla Walla, Wash.

The time and place for the first regular annual meeting for the presentation of papers was set for the week of the Inland Empire Teachers' Association at Spokane.

The following letter formulated by the Secretary and Council was sent to approximately 2000 persons in the states of Idaho, Oregon, Washington, Montana, and in the adjacent provinces of British Columbia, Alberta and Saskatchewan. This will present the aims and scope of the Association:

"This Association was organized at a meeting held at 4:00 p. m., April 6, 1923, in the Lewis and Clark High School, Spokane. According to the newly adopted constitution, the object of the Association 'shall be the promotion of scientific research and the diffusion of scientific knowledge', and 'membership shall include anyone interested in the purpose of the Association, on the annual payment of one dollar'.

"Forty-five Charter Members were enrolled at the organization meeting. It was the decision of the Executive Council that all those who respond to this call for members by payment of their dollar shall also be enrolled as Charter Members. It is the hope that there will be a very general response from all science workers or those interested in science in any of its phases, so that our new organization may become a real dynamic force in the Northwest. This appeal may not reach all of those who would like to become members, so those who do receive this letter are requested to become boosters for the Association and bring it to the attention of others who might be interested."

"The Northwest Scientific Association opens its doors to anyone interested in the various lines of scientific endeavor in botany, bacteriology, zoology, agriculture, home economics, mathematics, astronomy, physics, chemistry, geology and geography, anthropology, ethnology, psychology, education, social and economic science, historical and philological science, engineering, medical science and manufactures and commerce."

"One or more regular meetings will be held each year for the presentation and discussion of papers. As the membership grows, it is expected that special divisions or sections will be organized. This will depend entirely upon the membership and the interest manifested. It is hoped that the Association will promote acquaintance and friendship among science workers, a more active interest in science in general and that it will stimulate scientific research throughout the Pacific Northwest. At last we are to have an organization that will bring together the scientific workers who have hitherto been unable to attend such meetings because of the great distance."

"It is also the plan to publish the Proceedings of the Association. The scope of the publication will depend upon the funds which become available through membership fees or from other sources, but it would seem possible to at least provide for abstracts at the beginning and then include complete articles as our support grows."

"It is not the idea of the Association to interfere with any existing societies, clubs or organizations, but it is the hope that the Association may bring about an affiliation of all the organizations. It is also suggested that local groups or clubs be organized in the various colleges, normal schools, high schools or communities."

"We are counting on your support. Fill out the enclosed blank and mail it to Professor E. B. Harris, Treasurer, Spokane University, Spokane, Washington, before June 30th, and your name will be added to the list of Charter Members of the Northwest Scientific Association."

First Annual Meeting

As a result of this canvass, the membership was materially increased and reached a total of 229 at the time of the first annual meeting held in the Lewis and Clark High School, Spokane, on April 11-12, 1924.

Definite sections of the Association had not been organized, but the 51 papers offered for the Spokane meeting were grouped in the general sessions and in the following special sections:

Education:
A. A. Cleveland, Chairman.

Botany and Zoology:
Melvin A. Brannon, Chairman.

Medicine and Bacteriology:
Victor Burke, Chairman.

Chemistry and Physics:
C. C. Todd, Chairman.

Plant Pathology:
F. D. Heald and Chas. H. Hungerford, Chairmen.

Geology and Geography:
C. H. Clapp, Chairman.

The following Societies met with the proper sections of the Association:

Eastern Washington Branch, Society of American Bacteriologists, Victor Burke, President.

Northern Inter-Mountain Section, American Chemical Society, C. C. Todd, President.

Inland Empire Section, Pacific Division, American Phytopathological Society, F. D. Heald, President.

The regular business session was held at 9:00 a. m., Saturday, April 12. At this session the constitution was amended to increase the number of members of the Council at large from three to five. While Spokane has been designated as the headquarters of the Association for business purposes, it was the general understanding that the Council would locate the meetings at such places within the territory of the Association as they might consider advisable. The time and place for the next annual meeting was left to the decision of the Council. The following officers were elected for the ensuing year:

President—Melvin A. Brannon, Chancellor, University of Montana, Helena, Mont.

Vice-President—L. K. Armstrong, Spokane, Wash.

Secretary—F. D. Heald, State College of Washington, Pullman, Wash.

Treasurer—J. E. Wodsedalek, University of Idaho, Moscow, Idaho.

Councilors—M. F. Angell, University of Idaho, Moscow, Idaho; C. H. Clapp, University of Montana, Missoula, Mont.; Thomas Large, Lewis and Clark High School, Spokane, Wash.; Frederick Epplen, Spokane, Wash.; A. M. Shaffer, State Normal School, Cheney, Wash.

Second Annual Meeting

The Second Annual Meeting of the Association was held at the Lewis and Clark High School on April 10 and 11, 1925, with Chancellor M. A. Brannon, University of Montana, as President. Three general sessions and the following special sections were held:

Education:

J. H. Holst, Montana State College, Bozeman, Chairman.

C. W. Stone, State College of Washington, Pullman, Secretary.

Chemistry-Physics:

R. O. Hutchinson, State College of Washington, Pullman, Chairman.

G. F. Clukey, Lewis and Clark High School, Spokane, Secretary.

Botany-Zoology:

J. E. Kirkwood, University of Montana, Missoula, Chairman.

J. L. Slonaker, North Central High School, Spokane, Secretary.

Geology-Geography:

C. H. Clapp, University of Montana, Missoula, Chairman.

Thomas Large, Lewis and Clark High School, Spokane, Secretary.

Plant Pathology:

C. W. Hungerford, University of Idaho, Moscow, Chairman.

J. M. Raeder, University of Idaho, Moscow, Secretary.

Bacteriology:

S. C. Vandecaveye, State College of Washington, Pullman, Chairman.

L. A. Burkey, State College of Washington, Pullman, Secretary.

A medical program presented on the afternoon of the first day was open to the general public. The address of the retiring President, M. F. Angell, University of Idaho, Moscow, was delivered following the annual dinner in the Hall of the Doges, Davenport Hotel.

At the regular business session on April 10, two amendments to the Constitution were passed: one combining the offices of Secretary and Treasurer as a Secretary-Treasurer; the other providing for the retirement of one Councilor at large each year.

The following officers were elected for 1926:

President—C. H. Clapp, University of Montana, Missoula, Montana.

Vice-President — L. K. Armstrong, 720 Peyton Bldg., Spokane, Washington.

Secretary-Treasurer—F. D. Heald, State College of Washington, Pullman, Washington.

Councilors—M. A. Brannon, University of Montana, Helena, Montana—5 years; Thomas Large, Lewis and Clark High School, Spokane, Washington—4 years; M. F. Angell, University of Idaho, Moscow, Idaho—3 years; J. W. Hungate, State Normal School, Cheney, Washington—2 years; Geo. A. Downs, Old National Bank Bldg., Spokane, Washington—1 year.

Third Annual Meeting

The Third Annual Meeting of the Association was held in the Davenport Hotel, Spokane, Dec. 28 and 29, 1926, with Vice-President Armstrong presiding the first day and President Clapp in the chair the second day. Four general sessions were held, at one of which a medical program was presented. The following sections presented a program of sixty papers:

Botany-Zoology:

F. W. Gail, University of Idaho, Moscow, Chairman.

Nettie M. Cook, Lewis and Clark High School, Spokane, Secretary.

Chemistry-Physics:

J. A. Kostalek, University of Idaho, Moscow, Chairman.

G. F. Clukey, Lewis and Clark High School, Spokane, Secretary.

Geology-Geography:

F. W. Laney, University of Idaho, Moscow, Chairman.

V. R. D. Kirkham, University of Idaho, Moscow, Secretary.

Plant Pathology:

C. W. Hungerford, University of Idaho, Moscow, Chairman.

B. F. Dana, State College of Washington, Pullman, Secretary.

Forestry:

C. R. Stillinger, Office of Blister Rust Control, Spokane, Chairman.

Education-Psychology:

Arthur Kolstad, State Normal School, Bellingham, Chairman.

Social Science and Economics:

Section organized but no meeting held.
Dr. James G. Patrick, Chairman, Spokane University, R. R. 8, Spokane.
Miss Ruth West, Secretary, The Lewis and Clark High School, Spokane.

Movements are on foot for organization in the near future of Sections of Engineering and of Mathematics and Astronomy.

The Bacteriology Section was not represented as in former years but a Forestry Section was organized and papers presented for the first time. Arrangements were made for a Social Science Section for the next annual meeting.

The report of a committee composed of J. E. Kirkwood and Thomas Large, on "Larger Opportunities and Facilities for Research and Publication", was presented at the regular annual business meeting. The report pointed out the great service that might be rendered to the Pacific Northwest by the establishment of either a

Research Institute or a Museum or both and it was voted to place the further consideration of ways and means to bring about the desired end in the hands of a special committee of seven. The Council was further authorized to arrange for the incorporation of the Association as the first step to supporting the goal of this committee.

The following officers were elected for 1927:

President—L. K. Armstrong, 720 Peyton Bldg., Spokane, Washington.

Vice-President—E. C. Johnson, State College of Washington, Pullman, Washington.

Secretary-Treasurer — J. W. Hungate, State Normal School, Cheney, Washington.

Councilor—J. A. Kostalek, University of Idaho, Moscow, Idaho.

Dr. J. E. Kirkwood was elected to the Council for the unexpired term of J. W. Hungate made vacant by his election to the position of Secretary-Treasurer.

Constitution of the Northwest Scientific Association

ARTICLE I.

Name and Headquarters.

This Society shall be known as the NORTHWEST SCIENTIFIC ASSOCIATION and the Headquarters shall be at Spokane, Washington.

ARTICLE II.

Object.

The Object shall be the Promotion of Scientific Research and the Diffusion of Scientific Knowledge.

ARTICLE III.

Membership.

Membership shall include anyone interested in the purpose of the Association, on the annual payment of one dollar.

ARTICLE IV.

Officers.

The Officers shall consist of a President, a Vice-President, a Secretary and a Treasurer.

All Officers shall be chosen by ballot, on nomination of a nominating committee or from nominations made on the floor at an annual meeting.

Officers shall hold office for one year or until their successors qualify.

ARTICLE V.

Council.

The Council shall consist of the Officers and three members at large to be elected by the members present at the annual meeting.

ARTICLE VI.

Committees.

The Standing Committees shall be a Membership Committee and other committees appointed by the Council.

ARTICLE VII.

Meetings.

The Annual Meetings shall be held at such time and place as the Council decides. Special meetings shall be called by the Council.

ARTICLE VIII.

Amendments.

Amendment to this Constitution may be made at any Annual Meeting by a vote of three-fourths of the members present and voting, or at other meetings, provided notice of such amendment has been reported in the official program.

AMENDMENTS

ARTICLE I. The number of Councilors at large as provided under Article V shall be increased from three to five. (Spokane meeting, April 12, 1924.)

ARTICLE II. The offices of Secretary and Treasurer as provided in Article IV of the Constitution shall be combined as a single officer, the Secretary-Treasurer. (Spokane meeting, April 10, 1925.)

ARTICLE III. Of the five Councilors at large, one shall be retired each year. (Spokane meeting, April 10, 1925.)

*Eugenics and the Cost of Government**

By CHANCELLOR M. A. BRANNON, University of Montana, Helena.

We credit our age with marked scientific discoveries. Our age deserves all the credit for scientific advancement that it receives. Thus far, our scientific achievements have been most notable in the fields of invention and industrial development. However, much progress has been made in chemical, physical and biological research. Encouraging results are being secured in medicine. In education and the professions of law and ministry the forward movements have been retarded. The purpose of this discussion is to center attention upon some of the beginnings which have been made in one of the many sciences classified under biology in order that we may both evaluate the work already done and emphasize the need of more work in that science—the science of eugenics—in order that society in general and government in particular may be benefited. Thus far, we have been occupied largely with the problems of releasing, distributing and using mechanical power. We have made a slight advance in discovering how wastes may be prevented in releasing and utilizing the stored up energy of fuels, water falls and atmospheric currents. We have not made any considerable advance in discovering how the wastes caused by preventable diseases, the incorrect placement of the individual in vocational relationship, the unprofitable investment of surplus capital and the reduction of crushing taxes required to support the increasing hordes of feebleminded, insane and otherwise psychopathic individuals in the United States. Moreover, society in general is indifferent and inert in regard to these giant wastages which greatly penalize the welfare of humanity. The savings which might easily be effected by an informed, intelligent and dynamic society within a ten-year period, if all biological burdens could be reasonably diminished, would pay our national debt of twenty billions of dollars and build thousands of miles of the most magnificent highways known to highway engineering. It is because of this relationship which exists between biological economics and the cost of government that members of the Northwest Scientific Association are requested to stand at attention and give careful heed to the present day leaders in the studies of heredity, eugenics and preventable diseases. Among thse leaders may we remind ourselves that William Ernest Castle, Harvard University; Clarence Irwin McClung, University of Pennsylvania; John A. Detlefsen, Wistar Institute; Maude Sly, University of Chicago; Harry Gideon Wells, University of Chicago; Edward M. East, Harvard University; Roswell H. Johnson, University of Pittsburg; P. Poponoe of California; and Michael F. Guyer, University of Wisconsin, have been imploring society to listen to the ascertained facts discovered by hundreds of diligent investigators in plant and animal research. Their efforts have been ridiculed oftentimes by the press, and the "would-be funny" have facetiously referred to the science of eugenics as "choosing one's grandfather", and "the twins Eugene and Hygiene". They have utterly ignored the term "Eugenics" which, as we know, comes from the Greek language and means "well born". Oftentimes the press has confused society with general and loosely related statements relative to the science of eugenics, which is based on the great work of Mendel. It is the one science which points the way to the betterment of the race through the agency of sturdy and dominant ancestry.

The science of eugenics has two important divisions within which extended and important research has been developed. These two divisions are experimentation and statistics. The division of experimentation dates definitely from the pioneer work of the priest and botanist, Gregor Johann Mendel. The rediscovery of Mendel's work by DeVries acted as a stimulus for widely extended experimentation in studies of heredity in both plants and animals. The result of these researches have made it possible to formulate many definite laws of heredity. The terms "dominant" and "recessive" have come to signify both material and energy. The material is contained within the nuclear bodies called chromosomes, and the energy controls their behavior. Obviously, the field for research in the experimental division of eugenics is practically without limits.

The second division of eugenics, that is, the department of statistics, deals with the collection and interpretation of material secured in carefully organized surveys

*Address of Retiring President, Third Annual Meeting, Spokane, Dec. 29, 1926.

relative to improvement of species and races, relative to mentality of individuals both superior and deficient, relative to disease and many other problems which have an economic, social and political significance. It is because the surveys relative to mental deficiency point to serious social conditions which are becoming increasingly aggravated that I chose the subject of this address.

The costs of government have mounted so rapidly during the last few years that society in general has been stampeded oftentimes by the discussion of rapidly advancing governmental expenditures. It is now time that an analysis of the situation should be made and the constructive suggestions should be offered relative to the control of expenditures, the elimination of unnecessary costs, and suggested savings which will have particular value in preventing wastage in economic and social affairs. The closer the relationship between the suggested savings and the causes of waste, the more definite and positive will be their value. The desire to discover and remove causes of waste has prompted several important mental deficiency surveys. One of the most valuable studies was made in Wisconsin in 1920. The findings of this survey are reported in connection with data relative to delinquency of people in the penal institutions of Wisconsin, dependency of inmates in Wisconsin institutions for defectives, and mental testing of several thousand school children in various parts of the state. In the study of delinquency, dependency and mental handicap of school children it was found that the costs of government were mounting rapidly due to the mentally handicapped, feebleminded, epileptic, psychopathic and other mentally affected individuals. The Wisconsin Mental Deficiency Survey is so informing and suggestive that it deserves careful and detailed study. From the summary and conclusions the following interesting information and suggestions are taken:

"Approximately 12% of the prisoners in Wisconsin State prisons were found to be feebleminded; 12.6% of the inmates of the State Reformatory were feebleminded; 16% of the inmates of 17 typical county jails were found to be feebleminded; 17.5% of the inmates of county homes were feebleminded and over 50% were sub-normal; 9% of the inmates of state institutions for deaf were feebleminded and 8% of those in the State School for the Blind".

"An examination of 8009 children from typical public schools in country towns and cities reveal the fact that seven-tenths per cent of them were feebleminded; 1.1 per cent were borderline feebleminded, and 7% were subnormal. Three-tenths per cent of the total number examined showed evidences of psychopathic personality and two-tenths per cent were epileptic. In other words, the school population indicated that at least ten per cent of the 400,000 school children of the state required specialized training due to mental deficiency which could not be given in the regular grades at the public schools."

As a result of this searching mental deficiency survey the following are some of the conclusions expressed in the report:

"An outstanding need, as shown from this survey, is for greatly increased institutional provision, and special class facilities for the feebleminded. Basing the frequency of feeblemindedness on the percentage found amongst public school children in Wisconsin we would conclude that there are seven feebleminded persons to every 1000 of the population. This would make approximately 18,000 feebleminded persons in this state. If we take the army figures, as shown in Col. Bailey's report of the percentage of feeblemindedness amongst drafted men, we would have six feebleminded persons for every 1000 of the population. This would make approximately 16,000 feebleminded persons in this state."

"At present the state has provision for only 1126 feebleminded individuals in its two state institutions. Feeblemindedness is said to be three times more frequent than insanity; we do not believe that the size, menace and burden of this problem is fully recognized. Greatly increased institutional facilities are needed, as well as special class provision in the public schools and supervision out in the community."

"It is clear from our study that among the largest and most important causes involved in crime and dependency are mental conditions found within the individual criminals and dependents themselves. Mental disease and mental defect, epilepsy, psychopathic personality, abnormal mental trends, adaptive difficulties, and character defects, are, we believe, the most important factors underlying recidivism or repeated criminality and chronic pauperism. (Of 3977 dependents and delinquents studied, 50 per cent at least, every other person, was clearly classifiable in terms of deviation from average normal mental

health, was handicapped by some very definite abnormal nervous or mental condition; 10.3 per cent were found feebleminded. At least one out of every ten persons sentenced to state prison, reformatory, or industrial training schools, committed to state dependent school, county homes, orphanages, cared for and helped by relief organizations in this state, is a feebleminded person.)"

"There are two very definite needs deserving of serious consideration.

"(1) The provision of some machinery, which is now totally lacking, for the recognition of these conditions among prisoners in court, state prison, reformatory, jail, industrial training schools, almshouses, dependent institutions and out in the community; together with institutions of proper segregation, treatment and training, as well as kindly supervision of all needing such.

"(2) The development of measures for the prevention of factors which are the causes of these conditions."

"As regards the first point, there are no existing facilities for recognizing and handling these individuals who furnish all the disciplinary problems and slow down the industries, in the penal and correctional institutions, and furnish the very backbone to recidivism, chronic criminality, dependency and 'inherited pauperism'; there is no machinery whereby the feebleminded person, the early case of mental disease, epilepsy and psychopathic personality, may be prevented from being bandied about from court to jail, to reformatory, to state prison, back to court again, in and out of dependent institutions, and the like, until the time when something could have been done to prevent ultimate mental deterioration in the case of beginning mental disease, fixed criminal tendencies in the feebleminded, and dementia in the epileptics, has passed.

"It is our belief that one of the most urgent needs in connection with the penal and correctional machinery of this state today is the creation of diagnostic facilities, on the basis of which an intelligent classification of offenders can be made and proper treatment, training, and segregation instituted."

"We believe this end can be accomplished through the provision of $12,000 yearly for the creation of a staff of experts, a so-called 'flying clinic', to serve the state penal and correctional institutions, the state dependent home, state institution for the deaf and blind, and the courts when called upon. This flying clinic might well be attached to th Psychiatric Institute."

"This, with the gradual adaptation of existing machinery, whereby the adult defective delinquents may be segregated, and handled in a far more individualized way than at present, while the normal delinquents receive intensive industrial and vocational training, and early cases of mental disease transferred for appropriate hospital treatment, feebleminded children in industrial training schools, dependent schools and the like, committed to the state institutions for the feebleminded, will enable the state to care for its wards in a far more humane, intelligent and economical fashion than is at present being done."

"Are we not assuming an attitude of fatalism in our handling the problems of crime, dependency and insanity? Are we not spending millions of dollars in taking care of, punishing and endeavoring to cure individuals after these conditions have fully developed; and almost totally neglecting to dam the stream at its source, by instituting methods of prevention at a period when in a great measure prevention is possible?"

A survey of Wisconsin with reference to population and the number of feebleminded and insane may be used as a suggestive measure in the states of Montana, Idaho, Washington and Oregon. In Wisconsin the population in 1920 of 2,632,067 indicated that there were 18,000 feebleminded in that state. It is estimated that the insane equals one-third of the feebleminded. This would mean that there were 6,000 insane in Wisconsin. Using the same method of figuring feebleminded and insane in the states of the Pacific Northwest we should have for Montana, Idaho, Washington and Oregon the following figures:

	Population, 1920	Feebleminded	Insane
Montana	540,000	3,600	1,200
Idaho	432,000	2,950	983
Washington	1,357,000	9,000	3,000
Oregon	783,000	5,357	1,786

I am using the census for 1920 with reference to the population of our respective states. It must be remembered that these figures in regard to feebleminded and insane are estimates and approximations based upon a survey in the midwestern state of Wisconsin. It may well be that these figures are not properly apportioned in our Pacific Northwestern states. However, they are very significant and they point to the need and the wisdom of a

careful survey relative to the defective people in our immediate territory.

The present report on defective and delinquents in Montana shows the following facts:

Number of people in Penitentiary	427
Number of people in Insane Asylum	1,403
Number of people in Feebleminded School	258**
Number of people in Girls' Vocational School	79
Number of people in Boys' Vocational School	130
TOTAL	2,297

**16 blind, 79 deaf.

Obviously, and unfortunately a large number of the feebleminded and insane in the state of Montana, and the same statement applies to Idaho, Washington and Oregon, are not in state institutions under state control.

Notwithstanding the fact that only a portion of the defectives and delinquents are under the supervision and control of state institutions in our Northwestern states the following figures would indicate that our governmental costs in Montana, Idaho, Washington and Oregon reach large sums. This is readily seen from the report of the recent biennium appropriations for these four Northwestern states. The appropriations are as follows:

Montana Appropriations by 1925 Legislature for Biennium 1925-1927.

Montana State Hospital	$ 480,000.00
Vocational School for Girls	56,000.00
State Industrial School	90,000.00
Montana State Prison	340,000.00
Montana School for Feebleminded	294,000.00
TOTAL	$1,260,000.00

Idaho Appropriations—1923-1924.

Idaho Insane Asylum	$ 158,666.64
Idaho State Sanitarium	109,725.16
Northern Idaho Sanitarium	135,191.65
Idaho Industrial Training School	244,183.78
Penitentiary	154,289.07
	$ 802,056.30

Washington Appropriations—1921-1923.

Western Hospital	$1,069,150.00
Northern Hospital	657,500.00
Eastern Hospital	624,500.00
Custodial School	426,000.00
Girls' School	153,120.00
Reformatory	334,250.00
Penitentiary	494,990.00
	$3,759,510.00

Oregon Appropriations—1923-1924.

Eastern Oregon State Hospital	$ 401,200.00
Oregon State Hospital	860,139.32
State Institution for Feebleminded	490,000.00
State Industrial School for Girls	98,908.13
State Industrial School for Boys	159,613.57
Oregon State Penitentiary	521,916.02
	$2,531,777.04

Students of eugenics are agreed that a large amount of crime in the United States has a causal relationship to mental deficiency, and they are a unit in their belief that a large part of crime could be eliminated if the government could prevent the reproduction of the mentally deficient. If this is true the significance of eugenics in connection with the cost of government may be estimated from the following report upon the **annual cost of crime** in the United States:

"The best informed authorities agree the annual cost of crime in this country is not far from $10,000,000,000, covering loot of about $3,500,000,000, and $6,500,000,000 as police, insurance, prosecuting and prison charges, together with the economic loss in man power."

"Accepting these figures as reasonably correct, the cost of crime to each inhabitant of the United States is $83 a year."

"The American Bankers' Association, with a membership of 23,000 banks, makes the following estimate covering the direct loss of property in 1925 due to crime:

Embezzlement	$ 120,000,000
Credit frauds	400,000,000
Burglary, larceny and petty thefts	250,000,000
Forgery and spurious checks	75,000,000
Seaport robberies, piracy and customs frauds	100,000,000
Thefts from railroads	25,000,000
Stock frauds	1,700,000,000
Tax and insurance frauds	1,000,000,000
Arson	50,000,000
Miscellaneous	75,000,000
Total money losses due to crime	$3,795,000,000

"In an estimate made by Edward H. Smith for the Detroit Chamber of Commerce, with a slightly different classification, crime loot is set at $3,500,000,000. Burdette G. Lewis, Commissioner of Public Safety of New Jersey, arrives at the same conclusion."

"Charles R. Holden, president of the Chicago Crime Commission, made this remarkable statement regarding the activities of the underworld in that city:

"Chicago could afford to pay its 30,000 crooks not less than $20,000 a year each to retire from business or go elsewhere. If we could do that, the expenditure of $600,000,000 would be no greater than the cost of crime to Chicago under present conditions."

The costs of mental deficiency measured in appropriations for the support of institutions organized for the care of the deficient and delinquent and the large percentage of the cost of criminalism due to mental deficiency give only a part of the

picture, according to Michael F. Guyer of the University of Wisconsin, from whose writings the following quotation is taken:

"But bad as are these visible, measurable conditions, the disconcerting fact confronts us that as regards feeblemindedness, at least, they represent only part, possibly the least dangerous part of the situation. When feebleminded mates with feebleminded the offspring are all feebleminded. When feeblemindedness is crossed into normal stocks, the defect, following the Mendelian law, may become largely or wholly obscured in the immediately resulting offspring. Nevertheless, it is likely to reappear in later generations, with qualities undimmed. Such traits constitute what the geneticist terms a recessive. If an individual who carries feeblemindedness as a recessive marries one who is likewise a carrier, a common occurrence, one out of four of their children will probably be mentally defective, and two out of four may, like themselves, transmit the condition. This explains, for instance, how feeblemindedness may often appear among the children of apparently normal parents. The most disquieting part of the situation lies in the fact that in a fairly stable population where a relatively small proportion reveals a recessive defect such as feeblemindedness, there is always, through contaminations which have gone on generation after generation, a much larger percentage of the population who, though apparently normal, are carriers and therefore transmitters of the defect. Thus such evils are not being confined to the originally defective strains, but are thrusting theftuous roots into our better blood."

"Without entering into the details of their rather intricate calculations, it may be stated that two of our most careful investigators, in the field of heredity, Professors East and Punnett, have each come to the startling conclusion that with 300,000 visibly feebleminded individuals in the United States, with its population of over 100,000,000 there must be between 7,000,000 and 10,000,000 people who are carriers of feeblemindedness, any two of whom chancing to marry would probably have one child out of four mentally impaired, and two children out of four capable of transmitting mental impairment. This means that even if, in the United States, we could blot out all actively feebleminded at one stroke today, we should still have this enormous reserve of carriers who, marrying as usual, would produce a resurgence of approximately 100,000 active cases in the next generation. It should be noted that these calculations are for feeblemindedness alone and include neither epilepsy nor the insanities."

"Birth Rates of Normals and Defectives."—As matters now stand, however, we not only have this unavoidable increment launched on us every generation, but we are doing little to stay the torrent which is issuing from the matings of the plainly feebleminded, who family for family are outbreeding normal strains. In a recent survey of certain counties of Pennsylvania Dr. Key discovered that not only was the birth rtae of defective mothers more than twice that of normal mothers, but that the survival ratio of the young of such defective mothers was also more than twice that of the children of normal mothers. Dr. Kay found that 60 per cent of the good-for-nothings, drunkards, criminals, and sex-offenders of the regions studied belonged to ten feebleminded family strains."

"It is becoming more apparent every day as methods of precision are beginning to take precedence over guesswork that many of the 'down-and-outers' are not so because of lack of opportunity, but because of inherent incapacity. In the industries this is unquestionably an important factor in the problem of 'labor turn over'. For example, in a number of the Journal of Delinquency (March, 1917) before me I find that in a representative group of 107 unemployed men who applied for charity recently in Portland, Oregon, about one-fifth proved to be of the moron grade of feeblemindedness, and all were considerably inferior mentally to an ordinary group of successful men. Other studies of similar nature are bringing the same significant facts to light elsewhere in the country. And let us not forget that in a democracy the vote of each of these has just as much weight as that of the most enlightened citizen."

I have endeavored to offer statistical information showing the causal and intimate relationship between eugenics and the cost of government. In view of these salient findings from surveys of mental deficiency and crime society asks, what is the solution of this gigantic problem? Obviously, society must be educated and the public must learn the truth, first in regard to this enormous human wastage, and second its definite economic bearing on governmental procedure. If the public is informed in regard to the facts there will be a definite change from the present inert and complacent attitude which society everywhere evinces, in regard to this basic problem of

civilization. Careful and wise legislation will be enacted which will prohibit the reproduction of defectives and delinquents. This legislation will be expressed undoubtedly in eugenical sterilization and segregation into farm colonies of the unfit. Twenty-three states have enacted laws relative to sterilization with the result that six thousand two hundred and forty-four mental defectives have been sterilized. However, 4,636 were wards of the state of California, and only 1608 other defectives have been sterilized in the entire United States outside of California.

Speaking to this point Dr. Warren G. Murray makes the following contribution:

"A state has two major duties to perform in relation to the feebleminded. First, it must care for those persons of defective mentality who are unable, adequately, to care for themselves, and who, consequently, are a menace to the state. Secondly, it should seek, so far as possible, to reduce to the minimum the production of feebleminded persons. The quality of the members of the population during the next future generation in reference to inborn quality reproduce most abundantly. The foundation principle of applied eugenics demands fit and fertile matings among the members of the present generation who are endowed with the finest physical, mental and temperamental qualities, and it demands the prevention of reproduction by the present population who suffer from hereditary degeneracy."

* * * * * * *

"Modern segregation in state institutions is an effective method of caring for the feebleminded individual, himself, but it is exceedingly expensive and it is not an effective method of drying up the sources of production of the feebleminded. The lowest grades of the feebleminded cannot reproduce, and therefore, from the eugenical point of view, there is no eugenical motive in their sterilization. It is the borderline case who, with considerable supervision, can just about maintain himself in the economic world, which constitutes the greatest menace. Perhaps, the colonization of borderline cases in a system which could produce wealth to one-half the cost of maintenance and supervision, is an ideal to which state segregation should work."

* * * * * * *

"Not too much should be expected from eugenical sterilization in the beginning. Less than seven thousand persons have been rendered sexally sterile under the several eugenical laws on the subject since the first commitment in 1907, but it is well to go slowly, to develop the law, and its accompanying administrative machinery, and, at the same time, to train officers in pedigree analysis. The principle should be made to prove its worth by very conservative action, and thus if it demonstrates its value in cutting off defective inheritance lines, the state could use it more radically."

"A general principle of practical eugenics may be stated as follows: Every nation, state, community and family which produces a degenerate or socially inadequate person must be held responsible for the maintenance of such person. In consonance with this principle, international deportation, state return of defectives, and charging families for maintenance of defectives in institutions have developed. In logical extension, the state should demand, so far as it is able, the prevention of the production of defectives. The major factor of state-wide segregation, might well be supplemented by sexual sterilization of potential parents of defectives who are not segregated in the modern institutions."

Speaking to the same point Dr. Michael F. Guyer makes the following encouraging observations:

"Colossal as the undertaking seems, as a matter of fact, the initial cost would be the greatest item of direct outlay, for such colonies, once established, can by wise management be made largely or wholly self-supporting. We have considerable evidence based upon the actual experience of well-managed institutions that most feebleminded persons under proper supervision can do much work that is helpful to the institution or the state and healthful for themselves. Data from various sources all agree in showing that the economic value of the feebleminded, above the grade of idiot, is more than the cost of their care and maintenance. A recent example is that of twenty-five boys from one of the New York State custodial asylums, who were sent up into the Adirondacks for a month of camping, and given a lot of seedling spruce to set out. They did their work in a spirit of play, and yet at the end of their visit they had reforested a considerable area. A fair estimate placed the net value of the work to the state at $1,000, yet the cost of their transportation and keep for the entire period amounted to only $400. The fact is that many feebleminded individuals are physically strong, good-natured, irresponsible children, who remain happy and contented if kept under

reasonably comfortable conditions. It should be borne in mind, moreover, that with the reduction of the feebleminded there would also be a lessening in our expenditures on paupers, criminals, inebriates, and delinquents."

In this address I have quoted at some length from authorities on eugenics and human welfare. Their observations are sharp and clear. Obviously, this subject is one of monumental proportions and importance. Unless society recognizes and obeys the teaching of eugenics in regard to the cost of government in the perpetuation of civilization itself, taxation will advance rapidly and more than fifty per cent of all state and national revenues will be required to finance the care of wards within state institutions, and the costs will mount with increasing rapidity. An informed and aroused public clearly will provide, through eugenical sterilization and farm colonization, protection for the unfit and what is more important it will secure protection for the fit members of society. In a thoughtful address entitled "Human Destiny in Human Hands" Judge Harry Olson of the Municipal Court of Chicago said to a State Bar Association meeting:

"We can eliminate the criminal and the hereditary insane by segregating them in farm colonies and by sterilization and thereby reduce our taxes one-half."

"We can deflect from the public schools dangerous defective types to protected and humane farm colonies before they come to the juvenile and criminal courts."

"We can make the conservation of human resources the high aim of government and society."

"We can cease to make the individual the unit of society."

"We can make the family the true unit of society and by promoting racial hygiene increase the prestige and soundness of our nation."

"The future belongs to that nation which soonest and most effectively enforces a sound biological program."

Program of the First Annual Meeting

LEWIS AND CLARK HIGH SCHOOL
SPOKANE, WASH.
APRIL 11 AND 12, 1924

Abstracts of Papers

GENERAL SESSIONS

Opening Address.—PRES. M. F. ANGELL. (No abstract furnished.)

Science and invention in the van.—G. F. CLUKEY. (No abstract furnished.)

The agricultural experimentation system in the United States.—E. C. JOHNSON. (No abstract furnished.)

An interpretation of mutation. — E. B. HARRIS.

Mutation is a widely accepted theory attempting to explain the method of evolution. Its essential features are based upon Mendelism, which is a study in hybridization. Hybrids produced by crossing types with one pair of contrasting characters show the 1:2:1 ratio, one pure dominant, two hybrids, one pure recessive. If there are two pairs of contrasting characters, the ratio will be nine of the dominant type, three with one dominant and one recessive, three with the other dominant and other recessive, and one with one pure recessive. These ratios for any number of characters contrasted may be mathematically worked out. The square root of the combinations will be invariable, and two of this number will resemble the original types entering the cross. If there are as many as twenty-four pairs of contrasting characters, the total number of combinations in an ideal arrangement would be 271, 178, 127, 112, 936, two of which would resemble the original types, while 16, 467, 454 would be new invariable combinations. This makes it seem probable that so-called

mutations are only rare combinations which have arisen from pure homozygotes, and therefore breed true; that mutations are the result of hybridization, and do not account for the origin of new species.

The flowers and insects of Mt. Rainier.—A. L. MELANDER. (No abstract furnished.)

EDUCATION SECTION

The relation of science teaching to research in science.—J. H. HOLST.

Teachers of science in high school and college are prone to regard themselves as scientists and attempt to adopt what they think is the method of the research worker. They assume the guardianship of an accumulation of subject-matter which they feel called upon to defend against all comers. Thus so called science may become a cloak for ignorance when as subject-matter it is broken up and parcelled out by these self appointed guardians. He who is dull of comprehension may yet perceive a limited number of facts so that he can set up in some little realm of so called science and deny that any mind is capable of comprehending more.

They have appropriated the laboratory method and degenerated it. The obvious in the text is elaborated, the known is rediscovered and the inane form of "busy work" now happily gone from the primary school is still the vogue in the so called science laboratory. There are still the same old problems carried over from the last century. They are outlined for the student by a still more elaborate step-by-step cut and dried process. Everyone must do the same ones at the same time in the same way. Notebooks must be kept in the same old way, and students are not supposed to economize by bringing into use their father's unworn files. If there is anything that should be vital in education, it is science. If there is anything more inane than the average high school or college freshman laboratory, it is hard to name it. This make-believe drudgery is the most powerful influence to dishonesty in our educational system.

We must distinguish between the scientist as a research worker and the teacher of science. We need a Moses to go up into the mountain for the revelation, but we also need an Aaron to make the revelation known to the people instead of one who sets up the golden calf of sacred subject-matter. As the research worker is entitled to start with all the known data which he can use, so is the student entitled to what is known without being required to rediscover it as a mere form, or to acquire a technique which he will never use.

Individual differences in school children.—I. T. JOHNSRUD.

The schools and school-masters of former times, in providing one course, one line of school activity for all children were attempting to "fit square pegs into round holes". Many students of child development have evolved a firm belief, an established doctrine of Individual Differences so marked, so noticeable that "he who runs may read". Many experts and still more novices have become ardent disciples of tests and measurements of the abilities of school children. From these and from more intelligent and thoughtful observation, the conclusion has easily been reached that children's interests, likes and capabilities are widely different.

The writer conducted such a test, from which some interesting conclusions were drawn in regard to a large group of pupils just entering the Lewis and Clark High School, Spokane, Washington. Out of three hundred sixty-six pupils taking the test, which called for a total of 78 answers, one gave 16 correct answers and one at the other extreme gave 69 answers that were correct. Others varied between these two extremes, with 39 as the median score.

The study aids in confirming the idea that there is a large variety of ability in pupils of the same grade and apparently equal scholastic attainments. It aids in confirming the idea that the miscellaneous, the hit-and-miss assignment to classes of such a large number of pupils in a large school is not the best method of dealing with these pupils. They should be classified on the basis of carefully determined ability. The gifted child in a group of slow-going pupils is left the greater part of the time with no incentive to work. His time is given over to the development of bad habits, inattention, listlessness and dislike for school and its work. Neither is the slow-going child receiving the best out of school life when he is classified with pupils too far his superiors. The difficulty with both these classes of pupils could at least be minimized by placing pupils approximately of the same ability together in classes doing the same work.

The determination of a scale of distinguishable hues with special reference to purple.—FRANKLIN O. SMITH.

Published in full in Jour. Exp. Psychology 8:381-397. 1925.

Notes on the status of bird study in Normal Schools.—J. W. HUNGATE.

Replies to questions submitted to representative normal schools and colleges indicate that bird study is being offered by practically all, either as a phase of the course in nature study, or as a distinct course. Approximately thirty per cent of the normal schools are offering the latter type of work, while about ninety per cent are giving bird work in nature study courses.

In practically all cases the field trip is used extensively, the principal object of the course being apparently to enable the student to identify the common birds of the region. In a few schools the collecting of birds and making of skins is stressed, but these are the exceptions. Seventy-five per cent of the replies stated that a local list of birds was kept, forty per cent reported the keeping of a list of the campus birds, while twenty-five per cent reported the taking of a bird census, or counts. Migration records are compiled by thirty per cent. Bird banding has been done in only one or two instances.

Sixty-three per cent of the schools replying possessed bird skins or collections of some type, having acquired them through various means. Since numbers of specimens were not given in all cases, it is difficult to estimate the actual value of such sets. A few institutions are developing tracts of land near the school for use as bird refuges, thus combining the benefits of such refuges with their use as outdoor laboratories.

Replies indicate in general that although there is a good field for the development of such a course in normal colleges, such courses as are offered at the present time are not sufficiently well standardized and organized in comparison with existing courses in the normal school curriculum.

The true-false form of examination in College and High School.—C. W. STONE.

The true-false is one of several new forms of examination. It has several administrative advantages. These advantages prompted an investigation of its reliability.

Our plan of investigation is to secure a double set of scores for a number of different classes in a number of different subjects. That is, we have secured complete and detailed measurements by the usual traditional form of "exams" and a set of parallel measurements by the use of the true-false.

Our procedure has been to compare the placing of students by the traditional finals and by the true-false finals. This has been accomplished by computing coefficients of correlation. Our first essential has been to determine a criterion with which to correlate true-false finals and traditional finals. We have thus far used four types of criteria—intelligence scores, the average of all term grades, the average of previous grades in the subject, and the average of previous grades in all subjects.

SAMPLE COEFFICIENTS OF CORRELATION

Table I, Education 6, Spring, '23	N = 60	For T-F	Against T-F
True-F. Finals with average of Ed. Grades	.49		
Traditional Finals with same	.46	.03	
True-F. Finals with average of all grades except Education	.45		
Traditional Finals with same	.44	.01	
True-F. Finals with average of all Education 6 grades	.81		
Traditional Finals with same	.60	.21	

Table II. Geometry—Colfax H. S.	N = 50	For T-F	Against T-F
True-F. Finals with General Intelligence	.39		
Traditional Finals with same	.31	.08	

Of the eighteen pairs of coefficients computed to date, six are decidedly for, ten are slightly for, and two are slightly against the true-false tests. These findings are in accord with those of Dr. Gates of Columbia University, who computed fifteen pairs of coefficients based on data from ten classes, all in favor of the true-false. Thus it would seem that within the limit of the data thus far gathered, the true-false may be regarded as somewhat more reliable than the traditional form of examination.

BOTANY AND ZOOLOGY SECTION

The Pacific element in the Rocky Mountain flora.—J. E. KIRKWOOD.

The crest of the Rocky Mountains is a dividing line in more than a topographic sense; it divides the Atlantic and Pacific floras. While the division is not absolute, it is, nevertheless, conspicuous. There is considerable overlapping. The causes of the existing conditions are found in the geological past and the present climatic and topographic influences. Localities in the northern Rockies show affinity with the coast flora in proportion as their climate resembles the climate of western Oregon or Washington. As to the woody species, the means of seed dispersal and their prevalence in the Rocky Mountains agree largely with the agencies of rapid dispersal, such as prevailingly westerly winds. One of the most noticeable features in the case of those sparingly represented is more or less characteristic of plants on the edge of their ranges, viz., dwarf habit, sensitiveness to ecological conditions, lessened variability of form and structure, and lack of aggressiveness in propagation.

Osmotic pressure of cell sap and other physical factors as related to evergreens.—F. W. GAIL.

Published in full in Bot. Gaz. **81**:434-945. 1926.

In this piece of work the freezing point depression was determined by the use of the Beckman thermometer, and the osmotic pressure was computed on the basis of the freezing point depression. The needles or leaves were picked from the trees. They were then at once ground through a meat grinder, using the fine knife. A weighed amount of this pulp was now placed in a sack and the juice pressed out, using a definite amount of pressure. Tests have been made at least once a month for the past one and one-half years. The conifers used were *Pinus ponderosa, Abies grandis, Pseudotsuga taxifolia,* and *Larix occidentalis.* The broad leafed plants used were *Fraxinus lanceolata, Ceanothus velutinus,* and *Pachistima myrsinites.* The last two mentioned are evergreen.

It was found in non-deciduous trees and shrubs:

1. The least osmotic pressure of the cell sap for the species studied was in the latter part of June and the early part of July when the temperatures are high.
2. The osmotic pressure of the cell sap gradually increases after July and is the greatest in January and February when the temperatures are low.
3. Growth probably largely ceases after July and the photosynthetic products are stored in the leaves at least in part, which accounts for the gradual increase in osmotic pressure after July.
4. Growth appears to begin in these non-deciduous plants to some extent during the latter half of February and the stored substances are used in growth, causing a gradual decrease in osmotic pressures from February to June or July.
5. Probably the gradually increased osmotic pressures as the temperatures become low is a big factor in the retention of their leaves.

Deciduous trees:

1. There is no gradual consistent increase or decrease in the osmotic pressures of the cell sap of the species studied during their growing season.
2. There is an abrupt decrease in the osmotic pressures of the cell sap of these species studied after a sudden lowering of the temperature which would cause the cell sap to freeze.

Liverworts of Moscow Mountains and vicinity.—LOIS CLARK.

Practically no collections have been reported from Idaho except a few species collected by Roell in 1888. The following species have been studied by the writer:

Marchantia polymorpha
Conocephalum conicum
Riccardia latifrons
Riccardia multifida
Pellia neesiana
Jungermannia lanceolata
Lophozia porphyroleuca
Lophozia incisa
Lophozia longidens
Plagiochila asplenioides
Lophacolea heterophylla
Chilosoryphus pallescens
Geocalyx graveolens
Cephalozia media
Cephalozia bicuspidata
Calypogeia trichomanis
Lepidozia reptans
Blepharostoma trichophyllum
Ptilidium pulcherrimum
Scapania nemorosa
Porella cordaeana

Abandoned Acres.—HOWARD R. FLINT.

The utilization of each acre of land to the extent of its productive capacity is vital to the progress of civilization. This fact is not realized by many in the daily routine of life far removed from the sources of land products. The United States contains 81 million acres of neglected land capable of growing a crop. These are the "abandoned" acres which have been devastated by the removal of timber. Replanting by Nature has been prevented and man has failed to provide for reforestation. Of 822 million acres of old forest which we started with, we have left 463 million acres of potential forest land not suited to other crops. Our problem is the protection of these lands from fires, which is the greatest essential to the production of a new crop of wood. We should also support legislation designed to give the forests added protection and more consistent and thorough administration.

The biochemistry of fertilization.—E. A. FRANKS.

A brief review of the investigations by various scientists on artificial parthenogenesis brings out the fact that the function of development by the spermatozoon can be substituted by proper physico-chemical treatment. In this artificial process, the paternal influences of the nuclear material of the spermatozoon are absent from the embryo.

Evidence so far collected would lead toward the conclusion that the two functions of the spermatozoon depend upon different materials in its composition. Now it is not always the case that both of these functions make themselves manifest in the fertilization of the ovum, since the hereditary function may remain dormant or inactive while the developmental properties operate. Experimental hybridization was induced between the sperm of a starfish and the egg of a sea-urchin, this being accomplished in sea water that was slightly alkaline. The results of this were the development of plutei which were the same as the pure bred *Strongylocentratus purpuratus*.

There are on record other experiments that prove that it is possible to cause parthenogenesis by the spermatozoon. Under given conditions it is possible to cause development by spermatozoa that are foreign to the subject in question, and under these conditions there is no fusion of the nuclei of the sperm and the egg. The larvae that develop are found to contain only one-half of the number of chromosomes that are found when the nuclei unite, and they are purely maternal.

Multinuclear germ cells in the Columbian ground squirrel.—J. E. WODSEDALEK.

Cells containing two or four nuclei were rarely found in my studies on the germ cells of swine, horses, cattle, sheep and goats. Multinuclear cells are much more numerous in the testes of the Columbian ground squirrel (*Citellus columbianus columbianus*). A condition similar to that found in these rodents has never been recorded from any other animal. Tissue from over one hundred male specimens was examined and fully one-third of them showed cells with two, four and eight nuclei. In tissue taken from two of the individuals not only are the cells containing two, four and eight nuclei plentiful, but cells with as many as sixteen and thirty-two nuclei of the spermatid type, are fairly common; and occasionally huge cells with sixty-four nuclei of the same type are encountered. The two males concerned were vigorous full grown specimens and their germ cells were extremely active.

Relative abundance of varieties of birds in the Spokane County.—J. L. SLONAKER.

Following a discussion among members of the Spokane Bird Club as to the relative abundance of the different species of birds in Spokane and vicinity, it was decided to take a count of all birds during 1923.

The birds seen may be grouped in 4 classes as to numbers, namely, abundant, common, not common, and rare. Twice as many robins (995) were seen as any other bird, consequently we may call this species very abundant. The terms may be defined as follows:

Abundant.—A species whose numbers force themselves upon your attention at all times and places; usually seen from 100 to 500 times during the year. Number of species so classified, 11.

Common.—A species seen in goodly numbers on all field trips, but not in such large numbers as the preceding group. Number of species so classified, 25. (Seen from 50 to 100 times.)

Not Common.—Those seen in small numbers but regularly. Number of species so classified, 35. (Seen from 5 to 25 times.)

Rare.—Species not often seen. (Seen less than 5 times during year.) Number of these, 30 or more.

Not Placed.—Game birds, gulls, bank and rough-winged swallows.

	Our Ten Most Common Birds	Numbers Seen
1.	Western Robin	995
2.	Violet-green Swallow	486
3.	Brewer Blackbird	200
4.	Shufelt Junco	160
5.	Chipping Sparrow	154
6.	Yellow Warbler	150
7.	Mountain Bluebird	144
8.	Red-shafted Flicker	127
9.	Western Meadowlark	110
10.	Western Goldfinch	105

MEDICINE AND BACTERIOLOGY SECTION

Joint Session with the Eastern Washington Branch, Society of American Bacteriologists.

Treatment of hay fever patients with pollen extracts from local plants.—ROBERT STIER. (No abstract furnished.)

Preliminary botanical survey of hay fever plants of the Inland Empire. — T. A. BONSER.

During the season of 1922, a survey of the possible hay fever plants of the Inland Empire was undertaken by the writer for the Spokane Clinical Laboratory. Occasional spare hours and days were devoted to this work during the earlier and later parts of the season. Eight full days were given to this work in June and three full weeks in July and August.

The region surveyed comprised extreme western Idaho as far south as Lewiston, eastern and central Washington to Wenatchee, Ellensburg and Yakima, and from Milton, Oregon, to Pendleton and Umatilla.

The two most abundant and wide-spread possible hay fever plants are the Russian thistle (*Salsola kali-tragus* (L.) Moq.) and the Downy Brome grass (*Bromus tectorum L.*). The Russian thistle is without doubt a pernicious hay fever plant, but although the Downy Brome grass is so exceedingly abundant, it may be self-pollinated as oats are recognized to be, and hence need not be considered an important factor. The anthers of the Downy Brome grass never become so plainly evident as they do in the other brome grasses which are not so common, but which are still important factors in the production of hay fever, as these latter are clearly wind-pollinated.

Pollen was collected from a limited number of plants, and the writer was assisted in this work by Mr. Walter E. Flowers.

Specimens of the various hay fever plants and possible hay fever plants were collected, and prepared as herbarium specimens for the Spokane Clinical Laboratory. Microscopic mounts of the various pollens were also prepared. Mr. Walter E. Flowers made a series of photomicrographs and lantern slides of some of the more important pollens, as well as the plants themselves.

Ninety-eight hay fever plants and possible hay fever plants of this region were noted, collected, and prepared as herbarium specimens.

The prevention of deafness in children.—O. M. ROTT.

Published in full in the Volta Review 26, Oct. 1924.

After a short introduction, drawing attention to the importance of the subject, citing the frequency with which deafness attacks children and the per cent of deafness which is preventable, the author gives a short description of the mechanism of deafness, after which he enumerates the preventable measures to be employed.

These measures are discussed under the following headings:

(a) Removal of adenoids; (b) Removal of tonsils; (c) Removal of nasal obstruction; (d) Proper treatment of cold in head; (e) Proper treatment of recurring earache; (f) Proper treatment of running ears; (g) Proper treatment of acute infectious disease; (h) Removal of obstruction in external canal; (i) Prevention of injuries to ears; (j) Prevention of marriage of congenital deaf people and syphilitics.

The conclusion mentions the teachers' responsibility to this subject, quoting Harris's Group Test of Hearing by Whispered Speech, to show that many cases of incipient deafness may be thus discovered in a short space of time.

The value of alkali in dye therapy.—VICTOR BURKE.

The value of dyes as antiseptic agents in the treatment of infection has been firmly established by the work of Churchman, Davis, and others.

Experiments with gentian violet indicate that its bactericidal action on **Staphylococcus aureus** is measurably increased by the addition of alkali. The action of the dye is increased by a change in the hydrogen ion concentration from PH 6.6 to PH 7.4. It is believed that alkalization of the body fluids will enhance the value of internal dye therapy, and that the application of an alkaline compress before and after the application of the dye to infected tissues will increase the bactericidal action.

Published in full in Am. Jour. Med. Sciences 148:98. 1924.

Acidosis as indicated by components of the urine.—R. W. BARTON. (No abstract furnished.)

Research in nutrition.—

MARTHA KOEHNE.

The Nutrition Division of the Home Economics Department of the University of Washington has, for several years, been conducting feeding experiments on white rats. In general these experiments are designed to show the results of feeding to young rats types of diets that are commonly used in American homes, and which illustrate the numerous faults common to them. Some are low in vitamin content, some are low in lime, while some contain insufficient protein, and that present of poor biological value. Young animals are confined to their respective diets and the resultant effects on growth, rate of growth, reproduction, success in rearing young, span of life, and general well-being noted. The skeletons of all animals are saved, and most interesting effects of faulty diets are seen in poor bone structure, teeth, etc. Most remarkable effects are seen also in the general condition of the whole digestive tract, liver, spleen, heart and kidneys. Most attention is paid, in this work, to various types of diets low in lime, because the soil of Western Washington is so notably deficient in this element, so necessary to bone growth, and apparently to the normal functioning of the digestive tract. Pictures of many of these animals were shown, as well as the bones and skulls, and the growth curves.

The effect of sewage on the water of the Spokane River.—A. D. BUTLER.

In order to arrive at a scientific determination of the amount of pollution contributed to the Spokane River by Spokane sewers, samples have been taken monthly for the past eight years.

Samples are taken both above and below the city to determine what immediate effect the sewage has on the river. Samples are also taken at the mouth of the Spokane River to show what purifying effect is accomplished in flowing from Spokane seventy miles to the mouth of the river. Finally, samples are taken of the Columbia River, both above and below the mouth of the Spokane, to show what effect the Spokane River has upon the waters of the Columbia.

These samples are analyzed according to standard methods prescribed by the American Public Health Association.

In the chemical analysis the dissolved oxygen test is emphasized as being most indicative of the amount of pollution in the stream and the ability of the stream to assimilate pollution.

The bacterial analysis consists of total count on agar and the presumptive fermentation test for colon.

The conclusions that are so far drawn from a study of the results of these tests tend to show:

That the turbulent character of the river, with alternate settling and aeration, enables the Spokane River to assimilate more pollution than the average stream;

That, although the pollution from Spokane may be traced to the mouth of the Spokane River, its effect on the Columbia River is slight;

That the Columbia River below the mouth of the Spokane is less polluted than the Spokane River before it reaches Spokane;

That there is a decided degree of purification effected by the Spokane River from the city to the mouth of the river; and finally,

That, although the Spokane River is polluted beyond a point where it is safe to be used as drinking water, it is far from being polluted to the extent of being a nuisance.

Dormancy in bacteria. — GEORGINA S. BURKE.

A study was made of approximately 800 normal spores of *C. botulinum* to deter-

mine the time required for the spores to germinate and develop visible growth in favorable culture media under optimum germinating conditions. It was found that the majority of the spores germinated within 15 days in agar and 30 days in broth, but that a very few lay dormant, failing to show visible growth for a much longer period.

The maximum dormancy periods recorded were 92 days for spores in agar and 144 days for spores in broth.

Slow germination or dormancy of normal spores accounts in part at least for the slow germinations which have been observed in series of heated spores of *C. botulinum*.

Dormancy of normal spores may also explain the negative cultures obtained by certain workers from spores isolated by the Barber and other methods. Conclusions in regard to the viability of spores should not be based upon their failure to develop until the limit of normal dormancy for the species has been determined.

Published in full in Jour. Inf. Diseases 33:274, 1923, under the title "Dormancy or slow germination of spores under optimum growth conditions."

Pin-point colonies in cultures from milk.—ORLENA HAMMOND and FRIEDA DAUM. (No abstract furnished.)

Growing of algae in pure cultures.—LLOYD BURKEY.

Single-celled algae are studied in connection with nitrogen fixation, source of the synthesis of vitamines, and in the biological and chemical changes of lake water.

Single-celled grass-green algae are best isolated by the culture plate method. The medium used is Chodat-Grintzesco with the following constituents: $Ca(NO_3)_2$—1.0 gr., K_2HPO_4—0.25 gr., $MgSO_4$—0.25 gr., KCl—0.25 gr., $FeSO_4$—trace, Agar 10 gr., 1000 cc. distilled water. Growth occurred in three weeks sufficiently for transferring. Such a medium was used in the isolation of *Chlorella vulgaris, Scenedesmus quadricauda*, and *Dictyosphaerum pulchellum*. Maximum growth of *Scenedesmus quadricauda* on liquid media was obtained with Chodat-Grintezesco media without the agar. *Chlorella vulgaris* grew best on the following medium: $Ca(NO_3)_2$—1.0 gr., $MgSO_4$—0.2 gr., K_2HPO_4—0.2 gr., $CaCl_2$—0.1 gr., $FeSO_4$—trace, dextrose or sucrose—10 gr., 1000 cc. distilled water. They attained a growth in ten days which was calculated to be 0.75 of a milligram per cubic centimeter of media.

Blue-green algae could not be isolated on solid media. The Barber technique for picking single cells proved the best. They grew well in lake water to which yeast water was added or in lake water that was sterilized by passing through a Berkefeld filter in place of heating.

Contamination was detected by staining with a morphology stain, plating on glucose-yeast water agar. Sugars in the media also aided.

Results of work show that CO_2 is a limiting factor for algal growth, sugars beneficial for all organisms tried, and that the critical Ph varies with the organism. *Scenedesmus quadricauda* requires Ph. 7.1 to 7.3, while *Chlorella vulgaris* grows best in a medium with a Ph of 5.2 to 6.3.

Growth of the algae studied occurred best at 28 to 35 degrees Centigrade, in diffused light and in bottles or containers with large surface area.

The replacement of absorbed soil potassium.—S. C. VANDECAVEYE.

Published in full in Soil Science 17:91-96. 1924.

CHEMISTRY AND PHYSICS SECTION

Joint Session with the Northern Inter-Mountain Section of the American Chemical Society.

Dimorphic forms of Schiff's Bases.—C. M. BREWSTER.

Published in Jour. Am. Chem. Soc. 46:2463-2469. 1924.

Autolysis in seeds.—A. W. BARTON.

When seeds are placed in sterile media with or without sterile substrate, large volumes of gas are evolved during a period of from 15 to 30 days. The composition of the gas is fairly uniform in all cases, consisting mainly of carbon dioxide, methane, hydrogen and nitrogen. At times alcohol is formed in the media. Seeds thoroughly sterilized by being treated successively with (1) sulphuric acid-potassium dichromate solution, (2) alcohol, and (3) distilled water, placed in sterile media, do not generate gas during an incubation period of two to three months. Even

though kept under water during this time, the viability of whole seeds is not destroyed, since germination takes place when conditions favorable thereto are established. Autolytic activity is not due to micro-organisms. These experiments clearly indicate the origin of the gas to be due to the activity of micro-organisms. Enzymes within the seeds are not destroyed by severe means used to make them aseptic, or germination would not occur subsequently.

Oxygen and anodic passivity in metals.—A. M. SHAFFER.

The passive state of certain metals such as iron is readily attained by using the metal as an anode in an oixdizing electrolyte. The factors to be considered have been found to be: the particular metal, its condition and previous treatment, the nature of the electrolyte, its concentration, the temperature, the current density used, the time of passage of the current, and stirring or shaking of the electrolyte. To these must be added another factor, the concentration of dissolved oxygen in the electrolyte.

Using an electrolyte containing dissolved oxygen under pressure, it was found that for iron or nickel in sulfuric or nitric acid and at different temperatures, the effect of the dissolved oxygen was to increase the time required to reach the passive state and therefore to favor passivification, and the magnitude of the effect was found to be approximately proportional to the pressure or concentration of the oxygen. The effect of the oxygen is greater in more dilute electrolytes and is greater with sulfuric acid than with nitric. Evidence was found of a probable minimum current density required. The relationship between oxygen concentration, current density and time for the two metals and the two electrolytes at different concentrations are shown graphically.

The evidence points to the conclusion that if passivity is not due to the formation of a film of oxide on the surface of the metal it may be due to adsorption of a film of oxygen.

Arc and spark spectra of aluminum, zinc and carbon in the extreme ultra-violet.—R. O. HUTCHINSON.

Published in full in Astrophysical Jour. **58** (Dec. 1923).

Description of Apparatus and Methods Employed.—A grating spectrograph, inclosed in a metal tube which could be evacuated, was used . Evacuation of the tube was effected with a mercury diffusion pump. The arc was struck at definite intervals by means of an electro-magnet and an armature to which one of the terminals of the arc was fastened. The electro-magnet could be operated automatically or by a tap key. The latter method was usually used on account of the tendency to stick. The voltage across the arc could not be measured directly due to the intermittent character of the current, but it was less than 110 volts. Exposure was completed by this method in from five to twenty minutes. The spark was produced by an induction coil operated as a transformer on the 110-volt alternating potential, with a condenser across the spark gap, and with an auxiliary spark gap in series. As in the case of the arc, the sparking was intermittent, a short series of sparks being allowed to pass at intervals of about twenty seconds in order to allow the pumps to remove gases liberated from the terminals. A spark exposure required from two to five hours. Schumann plates on celluloid were used and were bent to the desired curvature.

Tables of Lines Measures.—The spectra of aluminum, zinc and carbon to λλ678, 467, and 460 were measured and the intensities of the lines compared. This represented an extension of the arc spectra of metals from λ1376, the lowest previously measured, to 595. An accuracy of 0.1 angstrom is claimed.

The electrometric titration of mercury with a titanous salt.—R. P. COPE. (No abstract furnished.)

The effect of chemicals upon the loss of carbon and nitrogen from decomposing wheat straw.—J. R. NELLER.

When straw is returned to the soil in an unaltered state, it often causes marked depressions in the yield of the succeeding crop. Experiments have been undertaken to test the effect of adding $(NH_4)_2\ SO_4$ and other fertilizing salts in an attempt to cause the straw to be partially oxidized or humified before returning it to the soil.

It was found that sulfur caused the oxidation processes, taking place in moist straw, to be practically inhibited. This was true both with and without the addition of $NaNO_3$. With each increase in $(NH_4)_2\ SO_4$ above 1.5 per cent, there was a correspondingly greater decrease in the loss of volatile matter from the decomposing straw. Ammonium sulfate in amounts less than 2 per cent caused a slight increase in the loss of volatile matter over

that obtained with water alone. Calcium carbonate added with $(NH_4)_2\ SO_4$ greatly increased the loss of carbon from the straw, but also caused a very marked loss of nitrogen from the $(NH_4)_2\ SO_4$ used. Experiments are in progress to determine ways of using $(NH_4)_2\ SO_4$ to aid in the utilization of straw without incurring excessive losses of nitrogen.

Heat conductivity of some insulators at various temperatures.—G. W. HAMMAR.

Thermal Conductivity. Radial heat flow method suggested by Niven (Proc. Roy. Soc. 76. p. 34. 1905). Geometrically and structurally near-perfect cylinders are produced from slate, various mixtures of concrete and fire brick. These are heated centrally by means of a resistance wire carrying direct current. The energy in-put is measured by means of calibrated ammeter and voltmeter. The temperatures of points on one radius in the middle of the cylinders are measured by means of Copper-Constantav thermocouples, using Leads and Northrup direct-reading potentiometer. Thermocouples are led through holes parallel to the axis of the cylinder so as to overcome errors due to conduction along the leads. Under steady conditions

$$\frac{E\ I}{L^\circ\ 4.187} = \frac{2\ \pi\ (\theta_1 - \theta_2)}{\log_e \frac{r_2}{r_1}}$$

where θ is the temperature of inner point. On the chosen radius, r_1 is the distance from this point to the axis of the cylinder, θ 2 is the temperature at an outer point on the same radius and r_2 its distance to the axis. E, I and L are respectively fall of potential across resistance, current, and length of cylinder.

The work being in progress, data is submitted on slate only.

Thermal conductivity of metals at high temperature.—M. F. ANGELL.

This is a continuation of some work done several years ago and published in the Physical Review, Vol. 33, No. 5.

The specimen is in the form of a cylinder with a small hole longitudinally through the center, heated electrically in a vacuum. At the center the heat flow is assumed radial and we have the relation:

$$\pi\ (r_1^2 - r_2^2)\ 1EI = \pi\ r1\ T \frac{dt}{dr}$$

Integrating:

$$\lambda = \frac{E\ I}{2(T_2 - T_1)} \left\{ \frac{r_1^2 - r_2^2}{2} - r_2^2 \log \frac{r_1}{r_2} \right\}$$

Where r_1 and r_2 are the inner and outer radii of the cylinder, E I the energy per second and T_2 and T_1 the inner and outer temperatures, respectively.

This must be multiplied by .239 to reduce to cal./cm. sec. degree.

Temperatures were obtained from thermocouples placed midway between the ends of the bar on inside and outside of the bar. The energy was determined by measuring the current flowing through the bar and a careful measurement of resistance.

For zinc, curves were shown giving the range of temperature difference between inside and outside; a temperature-resistance curve and variation of thermal conductivity from 0° C. to the melting point.

The free energy dilution of aqueous solutions of barium chloride.—R. W. GELBACH. (No abstract furnished.)

PLANT PATHOLOGY SECTION

Joint Session with the Inland Empire Section, Pacific Division, American Phytopathological Society.

Root-rot of wheat caused by a species of Helminthosporium. — C. W. HUNGERFORD and TRANQUILINE G. FAJARDO.

A rather serious root-rot of wheat has been found rather widely distributed over Idaho in both irrigated and dry farmed sections. The disease was first observed in 1919 at Rexburg, Idaho, and has since been reported from other points in both north and south Idaho. The fungus isolated from diseased plants has been identified as *Helminthosporium sativum* P. K. & B. This fungus has proven pathogenic upon barley, wheat, rye, spelt, emmer, oats and corn. Fifty-two varieties of wheat which were tested for resistance in the greenhouse varied very greatly in their susceptibility to the disease. Red Rus-

sian, Washington Hybrid 123, Defiance and Mosida were among the most resistant varieties tested, while Federation, Coppei, Pacific Bluestem and Red Bobs were susceptible. A careful study was made of the effect of temperature upon spore germination and upon infection. Rather high temperatures seem to be favorable to infection. The thermal death point of the spores was found to be between 50 and 55° C. when exposed for five minutes. Crown streak and spot blotch of cereals is suggested as a common name for this disease.

The inheritance of disease resistance.—E. F. GAINES.

Published with minor changes under the title, "The inheritance of disease resistance in wheat and oats." Phytopath. 15:341-349. 1925.

From a review of the literature, it appears that many species of plants contain individuals that vary in their resistance to specific diseases. When such individuals are crossed with susceptible races, resistant and susceptible segregates are obtained in the F_2 generation which breed true in subsequent years.

Investigating the inheritance of resistance to bunt in wheat and covered smut in oats, during the past ten years, at the Washington Agricultural Experiment Station, the author found resistance in wheat to be caused by multiple factors, the total effect of which produced many segregates that were susceptible and intermediate with few resistant. Turkey and Florence carry different kinds of resistance, which combined, make an immune wheat. Comparative resistance has been studied in 20 different crosses.

Two oat varieties have been found that are immune to covered smut—Red Rustproof and Markton. The inheritance of immunity in Red Rustproof has been worked out in crosses with the three susceptible varieties, Black Tartarian, Abundance and Large Hulless. Large numbers tested in the F_3 generation show dominance of immunity, but caused by three independent factors, any one of which is sufficient to prevent any smut. A variety of wheat immune to bunt and a variety of oats immune to covered smut are being increased for distribution to farmers. These two grains, Ridit wheat and Markton oats, have shown superior yield and quality as well as immunity to their major diseases during the past four years (1919 to 1923) and will probably soon become the predominating varieties of the Northwest.

The witches' broom disease of potatoes.—B. F. DANA and C. W. HUNGERFORD.

Published in full in Phytopathology 14:372-383. 1924.

Spot-rot of apples.—RODERICK SPRAGUE.

Published in full in Phytopathology 16:485-488, with F. D. Heald as joint author.

Experiments with inoculated sulfur.—J. M. RAEDER.

Work started in 1922 with various brands of sulfur, was continued in 1923. The results obtained were both interesting and conflicting. In the southern part of the state, in the irrigated section, although the Ph value of soil was reduced by the application of sulfur to the soil, control was negative. In one locality, the average Ph value of five checks was 6.72. Control of the scab on this plot was negative. In another locality with the average Ph reading of four checks being 8.79, control was also negative.

However, in the northern part of the state, in the cut-over section, reduction of the Ph value of the soil was accompanied by some control. In one case the per cent of clean tubers was increased from 5 plus per cent (average of four checks) to 60 per cent by the application of 300 lbs. of commercially inoculated sulfur to the acre. In another case, this percentage of clean tubers was increased from 8 plus (average of four checks) to 51 by the application of 600 lbs. of commercially inoculated sulfur to the acre. The average Ph value of the above mentioned four checks was 5.89.

The present status of white pine blister rust in the Pacific Northwest. — C. R. STILLINGER and S. N. WYCKOFF.

White pine blister rust is known to occur in the Northwest from the mouth of the Columbia River north to the northern limits of *Pinus monticola* in British Columbia and east to Revelstoke and Nelson, British Columbia. The infection south of the Canadian line has all been on Ribes, principally *Ribes nigrum* except for three infected pines found on the coast of Washington. In western British Columbia the disease is epidemic on pine. All investigations thus far have proved conclusively that the cultivated black currant is the most susceptible of all species of Ribes.

Plot studies in areas where the disease is epidemic show that all the trees in certain areas will soon be dead from the disease and in others the potential timber value of the stand will be destroyed within ten years. By means of quarantines and the general eradication of cultivated black currants, an effort is being made to retard the spread of the disease. Experiments are being carried on to develop a cheap and practicable method of removing the wild Ribes in commercial pine stands in order to protect these stands from blister rust.

The relation of white pine blister rust to Idaho forestry.—HENRY SCHIMTZ.

It is claimed that forestry in the Inland Empire is 90 per cent protection. In the past protection meant purely protection from fire, but in the future it will be necessary to consider protection from white pine blister rust. In all probability the existing fire protection organizations will broaden the scope of their activities to include blister rust control work. This will mean an increase in the size of the protective force and a more highly trained personnel.

The problem of protecting the mature stands of white pine is stupendous but economically possible. There are some 19,000,000,000 feet board measure of white pine in north Idaho, conservatively valued at $190,000,000 on the stump. When the necessity to protect these stands actually arises there is little question that they will be protected from white pine blister rust as well as from fire.

The big problem in Idaho concerns itself with the protection of the white pine reproduction from white pine blister rust. It is still an open question whether the private owner is warranted, under present conditions, to spend from one to two dollars per acre in protecting such stands.

It is these young stands which will make up the future forests of the state and it is absolutely essential from a forestry point of view that they receive adequate protection not only from fire but from white pine blister rust.

Unless economic conditions in the lumber industry change materially in the near future, some cooperative scheme between the federal government and the state and the private owner will probably have to be devised having as its aim the protection of white pine reproduction against blister rust.

The silver-leaf disease of the apple.—F. D. HEALD.

Silver-leaf, which is now known to be a disease of importance in widely separated regions in Europe, New Zealand, South Africa and North America, has been studied and found to be severe in portions of Eastern Washington. The causal fungus, *Stereum purpureum,* has been found on cultivated and native soft-wooded hosts including maples, alders, willows and cottonwoods from Walla Walla to the Canadian line. The disease has shown its greatest severity in the apple orchards of the Spokane Valley. Winter injury and under-irrigation are believed to be the most important predisposing factors, while the general practice of removing large limbs without sterilization or protection of the cut surfaces has offered many opportunities for infection. The sporophores were first found during the last of October and were prevalent in active condition during the balance of the winter period or until the cessation of snows and rain. The sporophores showed great variation in their form as influenced by available moisture, all extremes being found, from simple resupinate types to densely imbricated bracket or shelf forms, the latter type developing under conditions of abundant moisture. During the mid-winter months, the sporophores developed an intense purple color, which is believed to be the effect of the lower temperatures.

Published with additions in Proc. Wash. State Hort. Assoc. 19:50154. 1923.

GEOLOGY AND GEOGRAPHY SECTION

The oil possibilities of Southern Idaho.—V. R. D. KIRKHAM.

Published in the two following papers:
Oil possibilities of Southeastern Idaho. Mining and Metallurgy 6:71-74. 1925.
Oil possibilities and drilling activities in Southern Idaho. The Idaho Engineer 2:11-14, 18, 19. 1924.

The Grinnell Glacier.—M. J. ELROD.

Grinnell Glacier, in Glacier National Park, may be reached from Belton, via Lake McDonald and trail, 23 miles, or from Glacier Park by auto to McDermot Lake, 55 miles, and eight by trail.

The glacier rests on a shelf on the Garden Wall, faces northeast, covering an

area something more than a square mile. During the past ten years the ice has receded from every direction along the foot and sides. It is divided into two parts by a vertical wall, over which ice formerly cascaded. The foot of the glacier is melting away. Large caves occur where the ice flows over shelving rock. The caves fall in, and others form. One cavern was 200 feet deep and 50 wide, with ice roof and windows.

Surface boulders are numerous and large. One diorite mass weighs over a hundred tons. Crevasses and wells are numerous in late summer. Movement measured by Wm. C. Alden in a little over four days ranged from one inch to four and a half inches.

Hundreds of tourists visit the glacier each year, as it is quite accessible. Many pictures accompany the paper. The writer has visited the glacier several times and has traveled over much of the surface.

The origin of the Palouse soil.—J. D. McMACKEN.

Published in full in Pan-American Geologist 43:177-184. 1925.

Clastic dikes in Southeastern Washington. —O. P. JENKINS.

Many curious sand and dust dikes occur in Southeastern Washington, especially in a region west of Walla Walla. Those near Touchet occupy fissures in loose deposits and in stream terraces of cross-bedded sands and gravels. The dikes are structurally arranged in layers which lie parallel to the walls of the fissures. Some of the dikes are as thin as paper while others are several feet thick, and all have a tendency to branch. Their materials are of water worn basaltic sand and volcanic glass. The fissures might have been formed by earthquakes and their subsequent filling undoubtedly came from above. Their age is post-glacial.

A winter in Geyserland. — BEULAH BROWN. This paper presented a review of the story, "My Winter in Geyserland," which was published in the spring of 1924 for sale in the Yellowstone National Park.

This booklet tells of the author's opportunity to remain at Old Faithful Inn during the winter of 1922-1923 as a tutor to the three boys of the winter keeper. The geyser basin under winter conditions was described, also the use made of the geyser water. It not only heated the house, but also a greenhouse and chicken house, so that green vegetables and fresh eggs were always enjoyed in this snowbound region. A small electric light plant was another feature. Several trips on skis are described—the climax of the story being the 60-mile trip to West Yellowstone by Miss Brown and Mrs. Musser. The peculiarities and perils of skiing in a region so near to internal heat and the presence of animals feeding on the warm flats were other unique descriptions.

Drainage changes in the Columbia basin since the coming of the Columbia basalts.—THOMAS LARGE.

The introduction summarizes literature bearing on the subject and contrasts river behavior in this region with that of ordinary regions.

Part I. Printed in full in Pan-American Geologist 41:259-270. 1924.
270.

Part II. Describes ten large Miocene water courses and some small ones which are preserved "in negative" or "valley casts'" by the Columbia basalt; discusses the stream diversion by this invasion; makes inferences as to Miocene topography of the region; reviews effects of glaciation; adds to recent discussion of "glacial drainage" by Dr. Bretz and by the writer; treats phases not hitherto discussed; utilizes data of earlier workers and presents new field observations, several maps and photographs.

In order that nothing is omitted correspondence from members is invited concerning appropriations or other funds made available for scientific purposes, for the coming year. A full discussion of this has been asked for in our June issue. This should include funds for buildings devoted to scientific purposes, equipment, special investigations, museum, government funds for agriculture, forestry, geological survey and any other scientific purpose. As our field is so large, covering the four Northwest states of the United States and Western Canada, it will readily be seen that without a good deal of aid from our membership it will be impossible to fully cover this field. Information sent to any member of the publication committee will receive attention.

There is in prospect a supplement to the June issue of this publication, the material for which will be furnished by the Geology-Geography Section of N. W. S. A. It will be somewhat in the nature of a guidebook to the Inland Empire.

Scientific Notes and News

PROMOTIONS

A number of the early members and organizers of the Northwest Scientific Association have gone East to better positions: Dr. Curtis Merriman. one time Vice-President of the organization and member of the faculty of the State Normal School at Cheney, Washington, is now a member of the faculty of the College of Education, University of Wisconsin.

Dr. A. L. Melander, formerly head of the Department of Zoology at Washington State College and for twenty years or more State Entomologist, is now head of the Department of Zoology of the College of the City of New York. He was a Charter Member and a member of the Council of N. W. S. A.

Dr. Robert D. Baldwin, formerly of the Normal School at Cheney, is now President of the State Normal School of Stevens Point, Wisconsin.

WALCOTT MEMORIAL

Simultaneous meetings are being arranged as a Walcott Memorial to be held March 31st at the various educational institutions where there are groups of members of the Northwest Scientific Association, the hour to be determined by each group for themselves. The service should be short, the students and the public invited to attend and a resume of the Smithsonian Institution and the work and accomplishments of Secretary Walcott be reviewed. It is hoped that every member can be counted on to aid in making the event a complete success. If persons of other institutions are persuaded to hold such a service through this suggestion, so much the better. The loss of a scientist is a loss to the whole world, even though his works live after him. — L. K. ARMSTRONG, President Northwest Scientific Association.

A NOTABLE BIRD BOOK

From the Victoria Memorial Museum of Ottawa, Canada, under date of Sept. 15, 1926, there is issued "Birds of Western Canada" by P. A. Tavener. It is a remarkable book in every respect. As a model of popular presentation of scientific material it is unusual. Its colored plates by Major Allan Brooks and F. C. Hennessey are invaluable. Their truth to life and the beauty of landscape setting are hardly excelled. With two drawings to each plate, 168 in all. it may be said to be quite fully illustrated in color. The pen drawings of the text accompanying each species and those of beaks, feet and plumage used in the Key to Families are in surprising number and accuracy. An unusual feature in black and white is the silhouettes of hawks and eagles as they appear against the sky. As the area covered, from the Manitoba Ontario line to the Pacific, really makes this also a book of birds of Northwestern United States, no naturalist of our group will wish to be long without this work.

(Tavener. P. A.—Birds of Western Canada. pp. 380, 84 colored plates, many text illustrations. Paper 75c, cloth $1.25, 1926.)

The following members have been selected to act on a committee to study and report upon plans as directive to certain future activities of the Northwest Scientific Association which were discussed at the last December meeting, relative to larger facilities for research and publication:

Dr. J. E. Kirkwood, Chairman, Missoula, Mont.
Dr. J. R. Neller, Pullman, Wash.
Dr. George A. Downs, Spokane, Wash.
Dr. F. B. Laney, Moscow, Idaho.
Dr. H. S. Brode, Walla Walla, Wash.
Prof. Arthur Kolstad, Bellingham, Wash.
Dr. G. D. Shallenberger, Missoula, Mont.

It is proposed to hold a meeting of the members of Northwest Scientific Association in the afternoon or evening of April 7th, in the Davenport hotel, announcement of which will be made during the meeting of the Inland Empire Educational Association.

The Sigma Xi of Idaho University at its meeting on Tuesday, April 5th, will entertain the Sigma Xi Club of Washington State College. President C. H. Clapp of the University of Montana will be the principal speaker. Members living near enough to Moscow to attend this meeting are invited.

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Northwest Science

Official Publication of the Northwest Scientific Association

Application pending for entry in the post office at Cheney, Washington, as second class matter.

VOL. I JUNE, 1927 NO. 2

Geology Number

Presented by the Section of Geology and Geography,
N. W. S. A.
Virgil R. D. Kirkham, Chairman
Harold E. Culver, Secretary

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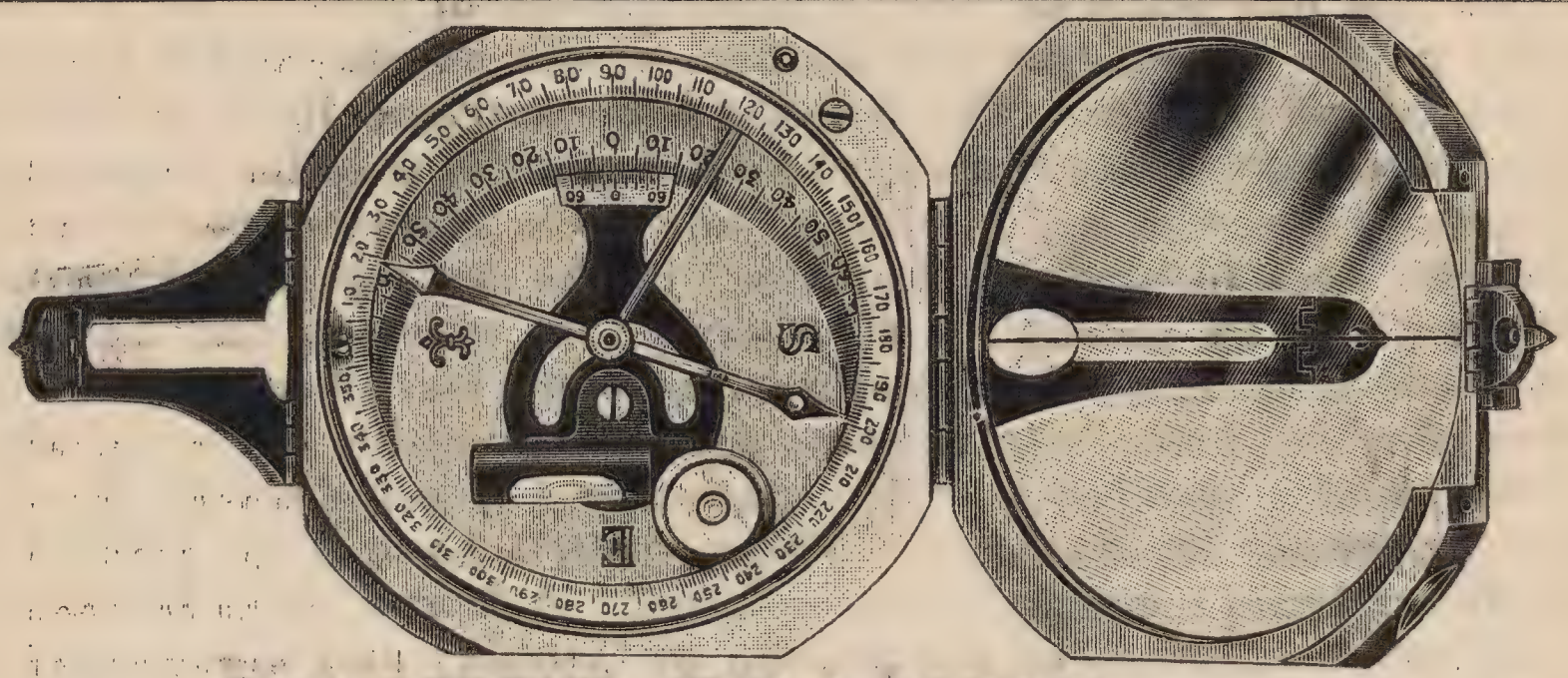

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Explanation

The past five years has seen a rapid growth of interest on the part of the public in geologic explanations of the physiographic features of the Inland Empire. This interest has expressed itself in "hiking clubs" and sightseeing caravans of local people, popular classes and lectures on geology, and in visits of university groups of students and scientists from beyond our borders. In the same period important investigations by geologists, physiographers, students and by amateurs with physiographic or geologic interests, have been carried on, some of which have been in some degree subversive of earlier ideas as expressed in textbooks on the subject and in some instances not a little surprising in character. These reports have been printed in widely scattered magazines and bulletins. A few of them have been given in the meetings of the Section of Geology and Geography of Northwest Scientific Association. None of these papers have been so technical in character as to be beyond the grasp of a reader of intelligence though untrained in geology. In this issue of NORTHWEST SCIENCE Professor Kirkham has presented a readable account of the geology of the region, together with condensed statements of the results of some of these investigations which will give, to the visiting geologist with limited time, or, to the general reader, correct ideas of the more important results obtained.

It was the original intention that this should appear as a supplement to NORTHWEST SCIENCE. Financial difficulties prevented. In order that Professor Kirkham's work should not be lost the Publication Committee decided to submit it as the regular issue of our magazine for the month of June. Several plans are being carried out to avoid the depletion of funds for regular publication due to the added cost of this issue. A most acceptable and important aid comes from the Idaho Bureau of Mines which assumed the cost of drawing the accompanying map and typing Prof. Kirkham's manuscript.

The Publication Committee confidently believes that this plan will further the aims of our organization: "the Promotion of Scientific Research and the Diffusion of Scientific Knowledge", as well as aiding in no small degree in popularizing science in the region we serve. With these explanations it is hoped that our membership will approve of the delay of publication of other abstracts of the second and third annual meetings.

The General Geology of Eastern Washington and Northern Idaho

By VIRGIL R. D. KIRKHAM,
Geologist, Idaho Bureau of Mines and Geology.

INTRODUCTION

Although several areas of the region commonly known as the Inland Empire have been examined and mapped by various geologists of the United States Geological Survey, by geologists of the Idaho Bureau of Mines and Geology, by geologists of the Washington State Geological Survey, and by many independent researchers and workers, no generalized geologic map of any large part of eastern Washington and northern Idaho has ever been prepared or published. Because of the interest shown by various geological excursions and scientific expeditions in this region, a need has been felt for a popular and generalized presentation of the outstanding geological features possessed by the region as well as a brief narration of the physiographic history and the processes and agencies which have determined its present surface and structure.

The Northwest Scientific Association, which is encouraging research in the Inland Empire region, has assumed the task of making some of this information available to the tourist, layman, and itinerant scientist, and consequently has delegated the preparation of this report to its Section on Geography and Geology, of which the writer is Chairman, and whose Secretary is Harold E. Culver, State Geologist, Washington Geological Survey, Pullman.

In the compilation of the map Dr. Culver and the writer have drawn freely upon all published material and also upon much unpublished data in the possession of the research organizations with which each is connected. This includes information made available by Dr. Culver's colleagues at Pullman and also by Alfred L. Anderson, Assistant Geologist, Idaho Bureau of Mines and Geology, for which deepest appreciation and thanks are expressed.

Appreciation is also expressed to the Idaho Bureau of Mines and Geology for the drafting of the accompanying map and for the typing of the manuscript of this report.

GEOGRAPHY

Location. — The eight 30-minute quadrangles of the accompanying map are grouped to extend from latitude 46°30′ to 48°30′ North and from longitude 116°30′ to 117°30′ West. The Washington-Idaho State boundary bisects the area from north to south. The city of Spokane, as can readily be seen, lies to the central western edge of the area.

Topography.—Several types of topography (72, 186, 205)* are represented in the area: (1) rugged mountainous provinces made up of tilted, faulted, and folded metamorphosed sediments, augen gneisses, massive basic igneous sills, and batholithic acid igneous intrusions with attendant stocks and cupolas; (2) plateau-like areas within the mountain masses (72, 186, 205) but lower than them, planed off by continental-glacier erosion; (3) the Columbia River plateau (170, 171, 177, 183, 187) made up of practically horizontal and gently tilted basalt flows; (4) the Palouse hills (166, 171, 177, 188, 198, 200, 210); (5) the stream-valley plains (186,205); (6) channelled scablands (171); (7) monadnocks; and (8) canyons.

Examples of types one and two are common in the northern and eastern part of the mapped area and types three and four are extant in the western and southern portions. Type five is common in the northeast and central parts of the map and type six lies west, south, and southwest of Spokane. The seventh type named is found in the southwestern part of the region as is also the last type.

The relief of the area from the Snake River Canyon southwest of Pullman to the mountains northeast of Spokane is nearly 7,000 feet. The drainage is entirely into the Columbia by way of the Clark Fork,

*The numbers in parenthesis refer to Bibliography of the Chief Publications on the Geology and Geography of the Inland Empire Country, p. 34.

the Spokane and Snake rivers, and their many and important tributaries.

Numerous small lakes formed by glacial scouring lie within the area and until recently morainal damming was responsible for several temporary and long-lived lakes of notable size. It still accounts for nearly all of the large lakes of the area.

The chief drainage to the northeast lies in deep, wide, glaciated, and often structurally formed, valleys. For the rest of the region the drainage follows valleys carved by running water, which valleys vary from extreme youth to late maturity.

The mountains represent minor ranges of the Rocky Mountain System and the Okanogan Highland.

Accessibility.—The area represented on this map is easily accessible by many railroads and excellent surfaced highways which make full use of the broad low valleys and rolling plateau-like areas. The rivers and lakes are navigable by steamers and launches but chiefly, as yet, serve tourists, vacationists and pleasure seekers.

Settlement and Occupation.—The population of the mapped area is less than 225,000. Spokane, a city of approximately 120,000, and the various county seats are the chief centers of population.

The population depends on the agricultural, lumbering, mining, and manufacturing industries. The region has many economic assets, with some of the largest forest stands and saw mills in the United States as well as the great Coeur d'Alene lead, silver, zinc mining district.

The famous Palouse soil and an irrigated Big Bend country give promise of continued agricultural prominence as also do the excellent white pine and pulpwood reserves insure continued lumbering enterprises. The ore reserves of the chief mines assure many years of life before a decrease in production can be expected. A tremendous amount of developed and potential water power is convenient.

GEOLOGY

STRATIGRAPHY

Archean (?) System (72).—Three localities in the area are occupied by schists and gneisses which are of such character as to seem much older than the Algonkian Belt series. One large area lies west of Lake Coeur d'Alene and south of Spokane. The other small areas lie east of Priest River and north of Clark Fork and south of Clark Fork chiefly in Idaho.

These outcrops probably represent ancient western buttresses from which the Belt sediments were eroded and deposited in a trough to the east and may have been exposed by erosion or never covered by the Beltian embayment. These areas are represented by oblique ruling on the map and are undifferentiated from other pre-Miocene rocks.

Algonkian System (Belt Series).—The Belt series (68, 72, 180, 186, 205), which is made up chiefly of quartzites and argillites, represent a series of conformable formations whose thickness varies from 17,000 to 30,000 feet within the area. These formations have become well-known because of their association with the rich mineral deposits of the region.

The Prichard formation, which is the lower unit, varies greatly from essentially quartzite in the north to highly fissile argillite in the south. It ranges from 8,000 to 10,000 feet in thickness. Throughout much of its area it is intruded by massive basic igneous sills of great thickness and frequency. In some regions the thickness of the sills alone is several thousands of feet.

Overlying the Prichard conformably is the Ravalli formation, which in a few localities is split into three formations known as the Burke, Revett, and St. Regis—from bottom to top. The latter is chiefly vari-colored shales and the others are quartzites. The Ravalli ranges from 4,000 to 8,000 feet thick within the area.

So far as is known the youngest Belt formation in the area is the Newland-Wallace. This formation is made up of calcareous and heavily iron-stained argillites and sandstones and some very impure limestones. The thickness varies from 4,000 to 5,000 feet. Ripple marks and sun cracks supposed to be indicative of shallow-water deposition abound in this formation. Basic igneous sills occur also in the Ravalli and Newland-Wallace formations. They were intruded in late Algonkian but Pre-Cambrian times in the approximately flat-lying Belt sediments.

Although a few small areas of downfaulted Cambrian sediments are known to exist east of Lake Pend Oreille and outside the mapped area none are known to lie within the map limits. The Beltian rocks are represented by oblique ruling on the map.

Tertiary System (Miocene Series) Latah Formation.—This formation (204, 206, 207, 212) was first described under that

name by J. T. Pardee, Kirk Bryan, and F. H. Knowlton in a publication of January, 1926. In the type locality these beds extend almost uninterrupted from Elk, Washington, to about ten miles south of Spokane. These beds of continental and lacustrine origin are very soft and have been eroded at nearly every place where they are no longer covered with basalt. Away from the Spokane area the formation is consistently interbedded with basalt flows and is exposed chiefly in cliffs on the sides of stream valleys. Its areal exposure in such places does not permit representation on the scale of the accompanying map.

The Latah beds are fossil-bearing shales, clay, sands, and gravel of a yellow to blue-grey color. According to Pardee and Bryan, the Latah formation has a thickness ranging from only a few feet to 1500 feet in the Spokane area and in that locality it lies unconformably on the older granites and gneisses. Throughout northern Idaho in wells, cliffs, and road cuts the formation is commonly found and is usually between two or more layers of basalt. This condition exists near Coeur d'Alene, at St. Maries, Potlatch, Moscow, Uniontown, and in Nez Perce and Clearwater counties south of the mapped region. In none of these localities does it show a thickness approaching 500 feet. Pardee and Bryan believe that the bulk of the Latah formation was deposited before the first basalt lava flows occurred, but at St. Maries and at other Idaho localities the writer has persuasive evidence that the first basalt flows dammed the existing drainage, and local small lakes and ponds were formed. As the damming was relieved, the ponds and lakes were eliminated and much, and in some cases all, of the unconsolidated Latah formation was washed away and cleared from the surface of the underlying basalt flow and valley walls. Naturally, ocacsional erosional remnants were left which were enclosed by subsequent basalt flows and which are now revealed by haphazard erosion and by the work of man in wells and road cuts. Except in the Spokane region the Latah appears to be local in character, without continuity, and variable in thickness. The formation is represented on the map by vertical ruling.

Quaternary System (Pleistocene Series) Lake Bed Sediments and Valley Fill.—The outline of much of the dotted and stippled area on the map is also the outline of temporary or semi-permanent lakes which resulted from the glacial invasion of the Pleistocene. These lake deposits were silts, sands, and gravels eroded from the nearby terrane. The usual phases of shallow water and delta deposition are exhibited in some of these areas.

Hill Wash and Alluvium (Recent).—This material, made up of a mixture of eroded materials from the mountains of the region, occupies the larger valleys and basins, and masks rock exposures except in gorge-like channels where it is cut through. It comprises the chief farming area of the region. In the area dotted or stippled on the map many areas of underlying bed-rock too small to map are exposed. In some instances they are only a few feet across.

IGNEOUS GEOLOGY

Batholiths (68, 72, 180, 186).—Parts of the Nelson and Idaho batholithic masses lie in the eastern and northern part of the area. Many outlying cupolas have been uncovered in the eastern part of the area. The magmatic intrusion which is believed to have occurred during Mesozoic (Cretaceous?) or Tertiary (?) times is now exposed chiefy as granodiorite, quartz-monzonite and granite. All of these are, of course, assumed to be differentiations from a common magma possibly dioritic in composition.

In the field the rock shows a uniform light grey and pink color and contains large phenocrysts of pink and cream colored orthoclase feldspars. Phenocrysts as long as two inches are common and Carlsbad twinning appears often. The plagioclase feldspar which generally is oligoclase, albite, or both, shows striations, and is white in color. Quartz is generally abundant throughout the areas observed. Biotite and hornblende occur in small quantities. Microcline and similar orthoclase types were observed as minor minerals in some specimens. The most notable field characteristic of this igneous rock is its porphyritic appearance caused by the immense orthoclase phenocrysts. Jointing is very common throughout most of the masses. These joints are commonly occupied by pegmatitic and aplitic dikes. Few basic dikes were observed. It is believed that these intrusions are undoubtedly parts of the Nelson and Idaho batholiths. An aureole of gneissic and schistose material with an average thickness of about 500 feet is commonly found as a transition phase. A few circular expanses

of this material, at a distance from the main intrusion, indicate areas underlain at a short distance by cupolas. Contact metamorphism is apparently greater at the roof than at the sides, on account of the presence there of more magmatic gases and altering agents.

The Moyie Sills (186).—These sills are distributed generally throughout the lower part of the Belt series and are particularly abundant in the Prichard formation, in which many different sills were observed. The Ravalli group of formations shows a few sills. The thickness of these great, injected, tabular, igneous masses ranges in this area from a few feet to 2000 feet. Because of their superior resistance to erosion they generally are exposed in ridges, peaks, or cliffs.

The lithology of these sills is variable but their main mass is made up of altered gabbro and diabase changed in many places by uralitization to a dioritic type.

Gravitational differentiation and magmatic segregation have produced, in a few instances, zones of quartz diorite and granite. The granite zone, where present, is always in the upper part of the sill and the quartz diorite seems to be a transition zone between it and the uralitized gabbro. The texture varies from holocrystalline to fine-grained in the thick sills and is sometimes porphyritic in the thinner intrusions.

The sills were intruded into the flat-lying Belt series and have consequently taken part in all the folding, faulting, and orogenic movements which built the Rocky Mountain ranges.

The stratification of some of the sills, which now stand at an angle of 60 degrees, makes certain that the segregation occurred in a flat-lying position. Columnar jointing perpendicular to the cooling surfaces was observed in thick sills.

Columbia River Basalt Flows (Miocene (?) Series) (170, 171, 177, 204, 207, 212).—As many as 26 different flows of basalt have been counted in the Snake Canyon in the southwestern part of the area. This section has a thickness of over 2,000 feet. Upon approaching the mountainous areas to the east and north the flows become progressively fewer and the total thickness of basalt becomes less. The older pre-Miocene topography, of higher relief than that at present, was inundated in some instances by wide-spread basalt flows encroaching from the west. In other instances, basalt flows from local sources filled intermontane valleys and flowed towards the plateau area.

Post-basalt erosion has since left rimrock flows, cliffs and terraces around Spokane, Coeur d'Alene Lake and up Coeur d'Alene, St. Joe, and St. Maries rivers.

Much of this basalt flood is believed to have been extruded from great fissures lying to the west and southwest of the area, but the writer (212) has recently found evidence, east of Potlatch, of old craters from which some of the material appears to have been explosively ejected. The basalt at this place rather than representing an embayment seems to have flowed onto the plateau as a tributary. At some places several feet of soil and occasionally more than 100 feet of Latah formation separate individual flows. This, of course, indicates the time intervals which existed between flows. In some cases this was apparently several hundred and perhaps even several thousand years.

The typical basalt is a dark, heavy black rock of varying texture. It is usually vesicular at contact surfaces and commonly shows columnar cooling joints. At Spokane basalt sills of small extent are intruded into the Latah formation. In the railway cuts of Latah Creek Valley are exposed basalt dikes believed by Pardee (207) and Bryan to be feeders to some of the basalt flows.

The basalt flows contain fire opal in some places and are used for road metal throughout the region. The more porous flows with their interbedded layers of silts and sediments make useful aquifers for underground water.

The Columbia River basalt is represented on the map by horizontal and vertical cross-hachuring. Overlying the basalt over the Columbia plateau area is a blanket-like deposit variously known as "Palouse soil", Palouse formation", and "Palouse hills" (166, 171, 177, 188, 198, 200, 210). It appears unquestionable that during Pleistocene times this blanket of silt, clay, and windborne dust formed a continuous and unbroken cover which has since been dissected and eroded away in some places. Elephant remains determine this loessal deposit to be Pleistocene and pre-glacial. Because of erosion this mantle, where present, varies from a few inches to 200 feet in thickness. Its origin, although much debated, seems to have been in more than one fashion.

Floods (170, 171), loosed by the sudden meeting of the Spangle lobe of the Spokane ice invasion, descended to the Columbia across this loess-covered, gently tilted, lava plateau, and in areas scoured the

lava surface clean, thus forming the scabland areas which are bordered by soft rounded "Palouse hills". This interesting phenomena has been fully described elsewhere (170, 171).

PHYSIOGRAPHIC HISTORY

In pre-Algonkian time the country near Spokane and to the north and south is thought to have represented a land area of some relief from which was eroded by running waters part of the 40,000 feet of Belt series which were deposited in the vast trough to the east. This depression extended roughly in a north-south direction for hundreds of miles and attained a width of nearly 200 miles in places. In all probability a few areas were never covered by the Belt series, and the ones showing at present may never have been submerged since pre-Algonkian tims.

After the Belt deposition and intrusion by the Moyie basic sills at the close of the Algonkian the area within the map never experienced another marine embayment. That major faulting and folding, tilted and disturbed the Belt series previous to the intrusion of the Nelson and Idaho batholiths is suggested by much evidence. These batholiths, which may be connected, stoped their way into the overlying rocks from beneath during Jurassic (?), Cretaceous (?), or Eocene (?) time. Subsequent erosion deroofed these magmatic masses at many points, and a region of fairly high relief and strong drainage lines was developed as far west as the present state boundary.

The region west of the mapped area, extending to the Pacific, was of low relief and of a coastal plain or plateau-like nature during early Tertiary (pre-Miocene) times.

In the general region of the present Cascade and Blue mountains, basalt lava came to the surface through great fissures and in large quantities and flowed in many directions. The great thickness of lava flows except along the edges of this great plateau probably conceal many sources for this vast expanse of basalt. Some few local sources have been located along the east side of the plateau.

As the flows piled up east of the present Cascade range a gradual arc-like subsidence, roughly marked at present by the main courses of the Snake and Columbia rivers in central Washington, began to take place. With this gradual subsidence came the gradual uplift of the arches which were to become the Cascade and Blue mountains. A similar but much smaller uplift took place along the north-south Spokane buttress, which once was the west wall of the Algonkian sea but now the eastern wall of an encroaching Miocene lava submergence.

With continued uplift and subsidence the high Cascades were developed and eroded and the now beveled edges of eastward dipping lavas occur six thousand feet above sea level. On the east slope of the Cascades west of the Columbia a thickness of 4600 feet of basalt has been measured.

At Pasco and Hanford, near the axis of the subsidence, the uppermost flow is scarcely above sea level. From there it rises gently to the east forming practically a dip slope to a height of approximately 2500 feet along the eastern mountains. The loess-covered plateau slope and scabland channels which now incline gently westward and southwestward from Spokane represent the lava surface after great subsidence on the west and slight uplift on the east. Tremendous areas of the plateau are known to be underlain by from 1500 to 2000 feet of basalt. Much of these original flows must now lie far below sea level.

Inasmuch as Alfred L. Anderson, Assistant Geologist, Idaho Bureau of Mines and Geology, has recently made a study of the physiography of the mapped area, the writer has asked him to prepare a brief abstract of his conclusions in regard to pre-basalt, pre-glacial, and glacial drainage changes in north Idaho and eastern Washington. Mr. Anderson says: "Before the coming of the Miocene basalt flows which have built up the Columbia plateau and formed embayments into the mountain valleys, the drainage was to the south and west. The Clark Fork flowed through the Pend Oreille and Spokane valleys to the west. Priest River occupied Hoodoo Valley and joined the Clark Fork near Athol. The St. Joe joined the Clark Fork near Coeur d'Alene. The basalt flows obstructed this drainage system and caused the deposition of 1500 feet of silts and clays in the Spokane Valley before the deposits were overwhelmed and buried beneath the basalt. This disarranged the former drainage system and probably caused a reversal of direction with the entire system passing north through the Purcell trench into Canada.

Subsequent erosion removed most of the basalt and Latah formation from the St.

Joe and Rathdrum valleys and now remnants only flank the valley sides.

In Pleistocene time the region was visited by at least two ice advances from the north, the first being the most etxensive and continental-like in character. This covered all but the tops of the higher mountains in north Idaho and etxended to increasingly lower altitudes through the Pend Oreille, Hoodoo, Rathdrum, and Spokane valleys to where it joined the Spangle lobe just a few miles east of Spokane, as described by Bretz (170, 171). The St. Joe drainage was blocked by this lobe which has been designated as the Rathdrum lobe by Anderson. Glacial Lake Coeur d'Alene, which was at least 500 feet deeper than the present lake and extended more than twice as far into the mountains, was held back by the ice. The outlet was along the south edge of the ice or on the ice into Lake Spokane, a body of water held in against the south side of Spokane Valley by the lobe. Part of the water leaving the lobe was probably subglacial, but some of it used the Mica Spillway through the mountains south of the Spokane Valley and joined Latah Lake, which had an outlet through the Pine Creek Channel near Rosalia.

The fluvio-glacial deposits and outwash filled in the Rathdrum, Hoodoo, and Spokane valleys in greater part to unknown depths, but in excess of 450 feet and probably in the upper Rathdrum Valley to nearly 1000 feet. These deposits dammed the mouths of the tributary valleys and by impounding caused Hayden, Coeur d'Alene, Spirit, Twin, Hauser, Newman, and Liberty lakes. Only Coeur d'Alene Lake has a visible outlet. The ice and subsequent gravel-fill effectively blocked the drainage of the St. Joe to the north and the present Spokane River was established. The river was superimposed on a formerly buried spur of resistant gneissoid and granitic rocks at Post Falls and this mass of rock is responsible for the present falls. At Spokane the river tumbles into the canyon of Latah Creek, which was established in pre-glacial times, and the falls there are the result of the river being suspended on a ridge of basalt.

The Clark Fork was held from its pre-basalt course through the Spokane Valley by the glacial-fill in the upper Rathdrum Valley and from its possible former course to the north by the retreating ice. It found a lower divide to the west and intrenched through about 200 feet of gravels, beheading Hoodoo Valley and isolating it from the former Priest River drainage.

The second advance of ice occurred in Wisconsin time. This was much less extensive and was more the valley type. The ice stream followed the Purcell trench from the north and left its terminal moraine at the south end of Lake Pend Oreille. Part of the outwash from this lobe, called the Pend Oreille lobe, extended down the Rathdrum and Spokane valleys adding to that of the earlier advance, but a part was also through the Hoodoo Channel and into the Clark Fork near Laclede. The Hoodoo Channel which connected the south end of Pend Oreille Lake with the Clark Fork was later stranded. The Pend Oreille lobe cleared the gravels left behind by the retreat of the earlier ice and Pend Oreille Lake remained held in by the gravel dam on the south and a second gravel divide near Elmira north of Sandpoint. The lake is 1100 feet deep and has a U-shaped bottom. A smaller lobe in the Priest River valley extended to the south end of what is now Priest Lake and on its retreat left Priest Lake behind a gravel dam.

The Clark Fork either at this time, or on the retreat of the earlier ice sheet, or on the retreat of each, stole the valley of an early southward flowing stream and reversed its direction from Newport to Metaline Falls, though it probably occupied the valley of the Little Spokane until the ice receded from the upper parts of the valley at Metaline Falls."

Abstracts of Important Papers Dealing With the Geology of the Inland Empire and Adjacent Country

By VIRGIL R. D. KIRKHAM.

Because most of the papers presented before the Geography and Geology Section of the Northwest Scientific Association during its three meetings have been chiefly concerned with physiographic development of northern Idaho and eastern Washington, the glacial history of the region, the Columbia basalt, the Palouse hills and the Latah formation, abstracts of a few of the

more illuminating papers on these subjects are hereby appended.

ABSTRACT OF NO. 145*.

In Davis' paper, only a part of which concerns north Idaho, he contends that a lobe of ice from the north occupied the Purcell trench as far south as Athol, that the lobe divided near Sandpoint, one passing down what is now Lake Pend Oreille to its southern extremity near Athol and overdeeping the valley by as much as 1000 feet, while the other branch passed up the Clark Fork Valley for about 60 miles. Damming of the Clark Fork Valley by the ice caused the formation of glacial lake Missoula. The valley train to the south of the Pend Oreille lobe formed gravel dams across the tributary valleys of Rathdrum and Spokane valleys behind which Hayden, Coeur d'Alene, Pend Oreille, Spirit, Liberty, and other lakes now remain. He also contends that Kootenay Lake in Canada and Pend Oreille Lake occupy the same valley and would be continuous if the intervening glacial fill were removed.

ABSTRACT OF NO. 170.

At least two ice sheets have invaded the northern portion of the Columbia plateau. The first known is the Spokane and the second is the Wisconsin. During Spokane time the ice advanced from the north to as far south as Spangle and Medical Lake. This is known as the Spangle lobe of the Spokane glaciation.

The ice barred the waters of Latah Creek and caused impounding with outlet through the Pine Creek Channel near Rosalia. With the retreat of the ice, Latah Creek assumed its former course. A later advance of ice assigned to Wisconsin age crossed the Spokane River in but one or two places northwest of Spokane. This has left little or no record in the Spokane vicinity.

ABSTRACT OF NO. 171.

The Columbia River plateau includes the greatest scabland area known in the world; about 2000 square miles of scablands exist here. The gently tilted plateau was covered by as much as 200 feet of loessal material before the Spokane glaciation and had developed a mature topography. The Spokane ice sheet approached the northern edge of the plateau and by blocking other drainage ways forced the waters of the melting glacier to cross the plateau to the Columbia. This was accomplished by a dozen routes across more than 150 miles of the ice front. The volume of glacial waters was high and the gradient steep so the glacial run off failed to stay in the old pre-glacial valleys. As the floods swept the loess from the basalt an anastomosing or braided pattern was developed and where the basalt was reached the rock basin and scabland areas were developed. This water spilled into the Snake and Columbia in three times as many places as the pre-existing drainage had used.

ABSTRACT OF NO. 207.

"The name Latah formation is proposed for a series of beds consisting mostly of clay and shale and of fresh-water origin that are found near Spokane, Washington, and that contain an abundant middle or lower Miocene flora. The formation is found in Latah Creek Valley for 10 miles south of Spokane, on tributaries of Little Spokane River for 20 miles north of the city, and in places in Spokane Valley for 8 miles northwest and 5 miles east of the city. It occurs also in at least one place in the broad, open valleys of the mountains near Coeur d'Alene, Idaho. These beds rest upon a rough surface of granitic and schistose rocks of unknown age, attain a maximum thickness of 1,500 feet, and are overlain by "rim rock" basalt flows, probably Miocene; "valley" flows, probably later Tertiary; and gravel of Pleistocene age. Sills and dikes, which represent some of the conduits through which the "rim rock" basalt rose to the surface, cut and to a small extent deform the Latah beds, which otherwise retain their original horizontal attitude."

"During Latah time the lava floods of the Columbia Plateau, advancing from the west, were held back from the Spokane area by a ridge, the highest parts of which now form the hills near Cheney, Marshall, and Medical Lake. The drainage outlet of this area was thus gradually obstructed by the lava, and the sediments here described were accumulated. Eventually the lava piled up until the "rim rock" flows were enabled to cross the protecting ridge and to overspread the area of Latah sediments."

"The "rim rock" flows consist of olivine basalt that shows very conspicuous columnar jointing. They are considered to be of Miocene age but are doubtless younger than the Yakima basalt. West of the submerged ridge they are apparently indis-

*The numbers refer to the Bibliography, p. 34.

tinguishable from the great series of flows that make up the Columbia Plateau."

"After a time interval measured by the cutting of valleys through the "rim rock" basalt and to a known depth of 800 feet into the Latah formation another series of basalt flows, referred to as "valley" flows, were extruded. These flows occupy parts of the erosional valleys and rest unconformably upon the Latah, exhibiting at the contact "pillow structure" and other characteristic features. They are distinguished from the "rim rock" flows largely by their topographic position, by a more varied jointing, and by the absence of olivine."

ABSTRACT OF NO. 210.

"The following conclusions seem justified:

1. The soil that is useful in agriculture (Palouse, Ritzville, Helmer series, etc., as defined by the Bureau of Soils) consists of a top skin, or veneer, that is largely windborne throughout the plateau and rests on material of various sorts.

2. Where the unconsolidated material, or so-called "Palouse soil", is thick the inner core of the hills composing the intricate topography is largely unknown. At various places this inner core consists of: (1) laminated silt; (2) almost structureless reddish compact silt with limy concretions that may be a loess; (3) yellow clay and clay silt that seem with little doubt to be loess; (4) ancient glacial till (older than the intermediate till of this region); and (5) very doubtfully a residual soil derived from basalt.

3. In the western part of the plateau there is in numerous valleys a well-defined terrace in part underlain by gravel. The valleys and the terrace antedate the great coulees formed by glacial waters.

4. The soil on these terraces is younger than the unknown inner core of the adjacent "Palouse soil" hills but is of Pleistocene age.

5. The soil on these terraces is a definite wind-deposited material as shown by the arrangement of the bones of an extinct elephant.

6. In the eastern part of the plateau thin and discontinuous layers of gray to green-gray material residual from basalt underlie yellow clay composed of minerals foreign to the basalt and having all the characteristics of loess.

7. In one place at least the top layer of soil or veneer contains volcanic ash.

8. The present rate of deposition of dust in the vicinity of Spokane is an accelerated rate induced by the cultivation of immense areas of loessial soil to the west and south.

9. Deposition of loess since the Wisconsin and intermediate bodies of till were laid down has been moderate in amount, and the great period of deposition of windborne soil antedates these later advances of glacial ice."

ABSTRACT OF NO. 183.

"The problem may be stated as follows:

Given:—(1) A region with nearly horizontal strata, uniformly possessing prismatic jointing, twice during the Pleistocene crossed by huge, short-lived, high-gradient rivers which eroded nearly vertically-walled channels and canyons;

(2) the retreat of the cliffs of these waterways, with maintenance of nearly vertical faces, and accumulation of talus at their bases as the only change of consequence in them since their formation;

(3) the channels active during each of the two epochs identified by (a) field evidence of the glaciated areas, and (b) the greater accumulation of talus in the older channels;

(4) the talus in the older channels three-fourths the height of the original cliffs, that in the later channels half the height of the original cliffs.

To find:—the relative lapse of time since each glaciation.

The solution is based wholly on the ratio of height of talus to height of cliff."

Answer:—A lapse of time 2¼ as great since Spokane time as since Wisconsin time.

ABSTRACT OF NO. 166.

The Palouse hills are great silt dunes. Dust storms are frequent. Drifting seldom takes place at present but in the past it must have done so; otherwise the dune-shaped hills extending at right angles to the direction of the prevailing winds cannot be explained. These soils have been blows from the eastern Cascades and the Columbia valley.

Dustfalls calculated during 1917 showed increment of 140, 184, and 585 pounds per acre. The estimated rate is 7,500 pounds per acre per year. An acre foot of this soil weighs 2,450,000 pounds per acre. At this rate an acre foot would be deposited every 326 years or 4 inches every 100 years. At least 25,000 years were necessary for the accumulation of the Palouse soil at the present rate of accumulation.

ABSTRACT OF NOS. 161, 164, 165.

Drift and till have been found near Cheney and southwest in Spokane, Lincoln and Adams counties which suggest a gla-

ciation earlier than Spokane which may be correlated with the Kansas ice advance.

ABSTRACT OF NO. 209.

"The writer previously suggested in Science an hypothesis for the origin and history of the Palouse loess. This summary is modified as follows:

(1) The Palouse Hills consist of loess, of which there are two phases, an original laminated phase which in composition is identical with the massive phase, but differs in structure and in being derived from the laminated phase.

(2) The Palouse Formation is not residual from the basalt as the formation is composed chiefly of quartz-grains, while the underlying basalt is practically quartz-free, and it does not appear to have been imported into the region as a dust deposit, but it was deposited by aqueous agents. It has many of the characteristics of glacial rock-flour, and from associated data, the most reasonable explanation of its origin, at the present time, is that this loess was laid down on the retreat of the continental ice-sheet, pre-Spokane in age, probably Illinoian or Iowan age, as has been suggested by Bretz.

(3) The relationship between the loess and the Snake River canyon indicate that it was deposited before the present uplift of the region. It is suggested thta deposition was effected as a flood-plain type of deposit, caused by the ephemeral flooding of the then existing drainage channels on the low-lying basalt which seems to be related to the Methow peneplain.

(4) A mature type of topography developed on the flat-lying Palouse formation.

(5) A period of deformation followed, the Palouse region being elevated and the Snake River thus rejuvenated."

ABSTRACT OF NO. 212.

The Latah formation at Potlatch occurs between basalt flows. Although these flows occur in the Potlatch area in what at first thought appears to be an embayment from the lava plateau to the west, local evidence suggests that the basalt from at least one flow was extruded forcibly from a local vent and flowed down the valley to the Columbia plateau. Well drillers describe drilling into cinder cones beneath the present basalt surface. So far as is known no cone or crater has ever been previously described in connection with the Columbia River basalt.

ABSTRACT OF NO. 187.

A description of "Lake Clark", ancient glacial lake lying along the course of present Pend Oreille River between Metaline Falls and Newport is given; also an old channel of the Clark Fork extending from Newport to Spokane is postulated. The outlines of old Lake Spokane are described and represented on a map. "Lake Clark" was about 60 miles long and six miles wide with occasional constrictions. The early drainage of post-glacial "Lake Clark" was by way of the Little Spokane Valley. The outlet of glacial "Lake Spokane" was through Mica Spillway, California Creek, Latah Creek, and North Pine Creek into Rock Lake. "Lake Latah" was an enlargement of Latah Creek formed by an ice dam near Spangle.

ABSTRACT OF NO. 204.

Four basalt lava flows were found to have extended up the St. Joe and St. Maries rivers. These flows were conformable but separated by long time intervals. These intervals, however, were very likely no longer than those which occurred during the building up of the great plateau to the west.

Erosion since extrusion has dissected the originally level surface until now the basalt is exposed as terraces, mesas, and buttes near and between the larger streams which have cut through the lava.

The Latah formation at this place is found between lava flows. Occasional erosional remnants which remained after damming was relieved were trapped by the next basalt flow. At places the basalt flows contact with no parting, at other places the same flows are separated by 100 or more feet of Latah formation. The flows are all valley flows representing Miocene basalt from the western embayment.

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By VIRGIL R. D. KIRKHAM.

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Unpublished manuscripts submitted by Solon Shedd, Supervisor, Division of Geology State of Washington (6-1-1925), Department of Conservation and Development, Olympia, Washington, submitted as Bul. **32**, Washington Geological Survey. Available for examination, Office of Conservation and Development, Olympia, Washington.

PIONEERING IN GEOLOGY*

Another geological pioneer in the region of Central Washington was Israel Cook Russell, who was sent into this region by the U. S. Geological Survey and made the first systematic reconnaissance of the area east of the Cascades in 1892. While this paper does not touch the area covered by Prof. Kirkham in papers appearing in this issue of NORTHWEST SCIENCE much of what he sets forth is fundamental to the understanding of this area lying at the northeastern edge of the lavas of which he made these fundamental studies.

The paper concludes with descriptions of fossil leaves found in the John Day System, written by Dr. F. H. Knowlton.

GEOLOGICAL LIBRARY

Many members of Northwest Scientific Association are not aware that our President, Mr. L. K. Armstrong, with offices in the Peyton Building in Spokane, has one of the finest geological libraries in the Northwest and that they will be welcomed by Mr. Armstrong if they wish to use it as a reference library.

*U. S. Geol. Survey Bul. **108**. 1892.

Abstracts of Papers

presented before the

GEOLOGY SECTION OF NORTHWEST SCIENTIFIC ASSOCIATION

at the

SECOND ANNUAL MEETING
THE LEWIS AND CLARK HIGH SCHOOL, SPOKANE, WASHINGTON, APRIL 10 AND 11, 1925

C. H. Clapp and L. K. Armstrong Presiding.

Peculiar sand structures in the Metaline district, Washington.—O. P. JENKINS.

Extract from the paper, "Clastic dikes of Eastern Washington and their geologic significance" published in Amer. Jour. Sci.

Evidences of the origin and age of the Palouse loess formation. — RAYMOND TREASHER.

Abstract published in Science 61: 469. 1925.

Some observations on the occurrence of oil and gas in Montana.—O. W. FREEMAN.

Oil was first discovered in commercial quantities at Elk Basin in southern Carbon county in 1915. This was followed by a discovery at Devil's Basin in Nov. 1919, and at Cat Creek in central Montana in March, 1920. Oil has since been found at Soap Creek in Big Horn county, Kevin-Sunburst in northern Toole county and in the Big Lake field near Billings. Commercially important gas deposits have been found near Shelby, Havre, Glendive and Baker and probably Chinook and Billings. Cat Creek and Kevin-Sunburst are served by pipe lines and produce over 3,000 barrels daily. Some oil is shipped to Wyoming, Canada and even Indiana for refining. Lewistown, with two refineries, has the largest output of refined products in the state.

The producing sands at Cat Creek are in the Kootenai formation of lower Cretaceous age. At Kevin-Sunburst the chief sand is in the Ellis beds of Jurassic age although some oil has come from the Kootenai and the top of the Madison limestone of Mississippian age. The oil at Soap Creek and Devil's Basin is very heavy and occurs in the Quadrant formation of Pennsylvanian age. The gas at Havre and Glendive, and the oil of Elk Basin occurs in Cretaceous rocks.

Except at Kevin-Sunburst where oil occurs in a very large broad flat dome, petroleum has not been found except in domes with dips of ten degrees or more. Faults have had a great influence upon accumulation of both oil and gas. Solution and weathering at the top of the Madison limestone has created enough porosity for an oil reservoir at Kevin-Sunburst. The great proportion of favorable structures in Montana are unproductive and hundreds of dry holes have been drilled. Some of the reasons for non-production are: intrusion of igneous rock and intense folding that caused too much metamorphism, lack of porosity in possible sands, too great water pressure that flushed out the oil, poor location of wells, and drilling stopped before all possible sands were tested out.

All of Montana's oil fields so far discovered were the result of applied geology. There were few surface indications except favorable structure. The state should increase its production of oil in the next few years and be an important producer for a long time.

The Ft. Wright whirlwind of May 20, 1924. —E. M. KEYSER.

On May 20, 1924, at Fort George Wright Army Post, 2½ miles northwest of Spokane, Washington, an unusual phenomenon developed, popularly called a "cyclone", but which critically analyzed, is seen to be only a violent whirlwind.

The site of the whirlwind is a tableland of several hundred feet above the south bank of the Spokane River. On this plateau is an elliptical driveway with buildings on north and south ends and west side, including Headquarters', Lieutenants' and Captains' buildings, near which were a tennis court, garage, and the Post Exchange building.

The twister was first seen at the north end of the grounds near Headquarters' building and tennis court moving south toward the Lieutenants' building. It lifted metal and ash cans high into the air, demolished a $200 garage, broke down the Fort's light and telephone wires in overthrow of two telephone poles, shoved the Exchange building on its base, passed

close to the hospital building at the south end of the grounds and disappeared over the gorge where it was apparently dissipated.

With Spokane Weather Bureau records as a basis of study, the whirlwind is seen to have followed a dry spell, long period of excessive sunshine, little cloudiness, and low humidity. It occurred on a day of normal pressure, no marked barometric fluctuations, and with practically a clear sky and a light wind. The table-land was excessively heated and above it was a stratum of superheated air over which was a layer of cooler air. The most unstable point was probably over the heated tennis court where the whirlwind likely broke into being. Starting on a small scale, a contraclockwise motion developed and the whirl advanced with increasing momentum. Its course was dependent upon temperatures encountered and the general air drift at the time.

The whirl's tornadic characteristics were mid-afternoon occurrence, its destructive effects, its narrow track, its gyratory motion and its roar. But essential tornadic earmarks such as upper air origin, V-shaped "Low" parentage, and funnel cloud, were missing.

Some features of the Eagle Creek formation.—IRA A. WILLIAMS. (No abstract furnished.)

Lake Lewis due to flood waters of Spokane ice.—J. G. McMACKEN.

The paper first reviews the conditions on the Columbia Lava Plateau following its building up by the successive floods of lava. It describes briefly the formation of the canyons by the rivers in the basalt and the warpings to produce the divides and structural basins. The outline of Lake Lewis is described as indicated by berg dropped eratics, gravel deposits, and some poorly defined shore lines.

Several hypotheses for the formation of the lake by different geologists are then taken up. It describes the extent of the great ice front of the Spokane Ice. It offers as an explanation of the source of the mighty floods from the melting ice that filled all the old river channels and structural basins to overflowing, the melting due to the short hot summers and the milling caused by the enormous pressure due to the great depth of the ice which covered all but high peaks and caused the ice, when in the lower valleys, to melt and the waters to issue as immense floods from beneath the ice front. It takes up the different channels of these floods as they swept southward to produce the channeled scablands as described by Bretz. It reviews the measurement of these flood waters by Bretz and brings out the fact that old drainage lines were all too small to carry them and that they flooded back into the Hartline, Quincy, Pasco, John Day, and Willamette basins to produce the temporary bodies of water known as Lake Lewis. The lack of shore lines of this lake is explained on the basis of the seasonal character of the glacial floods which would cause the elevation of its shore lines to change greatly from winter to summer.

Products of metamorphism in Stevens County.—W. G. BENNETT. (No abstract furnished.)

Columbia basalt, few flows or many?.—V. R. D. KIRKHAM.

Public statements by certain geologists that only a few basalt flows are known to constitute the Columbia river plateau, prompted this paper as a reply. The writer contends that the flows are numerous, and extensive, and that the basalt occurs at great depth.

Statistical tables and maps, concerning only the Columbia plateau, show the location of forty stations, and the number of flows and lava thicknesses at each, as exposed by stream-eroded canyons, and well logs. The average number of basalt flows shown at the forty stations is ten. The average thickness of basalt shown is 1500 feet. The greatest number of basalt flows counted by the writer is twenty-eight, and the greatest thickness of basalt reported was 4600 feet. Locations were spotted accurately on a large scale map so that any investigator might check the data presented.

Preglacial age of deep oxidation in the lead and zinc deposits of northeastern Washington.—O. P. JENKINS.

Published as a portion of "Lead Deposits of Pend Oreille and Stevens Counties, Washington." Dept. of Conserv. and Dev., Division of Geology Bul. 31, 1925.

Detailed geology of the Cleveland mine.—VIRGIL E. BARNES.

Published in "Lead Deposits of Pend Oreille and Stevens Counties" by O. P. Jenkins as cited above.

A hitherto undescribed Pleistocene drainage channel southward from Lake Coeur d'Alene.—THOMAS LARGE AND W. A. ROCKIE.

During the summer of 1926 we observed what appears to be a comparatively small abandoned drainage channel at Plummer, Idaho. This seems to lead southward from

the valley occupied by Lake Coeur d'Alene. The Chicago, Milwaukee and St. Paul Railroad uses this channel at this point and from them we have obtained the elevation of 2650 feet. These figures are highly significant for it was at the level of 2650 fet that Hershey* found the supposed "ice-rafted" boulders in the valley of the Coeur d'Alene River near Kellogg, Idaho.* As this is 150 feet above the highest known level of the Pleistocene Lake Spokane (Large, Science, Sept. 1922, and Pan-American Geologist, Dec. 1922), the inference is that, as Hershey supposed, an ice dam was formed at the northern end of Lake Coeur d'Alene, which raised the lake until it overflowed southward, perhaps at the time of the Spokane Ice. The fact that the channel is small by comparison with the drainage channels of Lake Spokane is no doubt due to the fact that it carried only the waters of the Coeur d'Alene and St. Joe Rivers instead of the entire drainage of the west slope of the Rockies from the Clark Fork northward as the outlets of Lake Spokane must have done.

The senior author of this note had believed that the difference in levels at which Hershey's boulders were found and the levels at which he had found the outlets of Lake Spokane might be explained as due to warping of the earth surface. While the finding of this outlet at this level does not entirely discount this explanation the fact that the bottom of the Plummer Channel is the same as the elevation of the boulders, together with the size of the channel seems to make an ice dam at the present site of the city of Coeur d'Alene the more probable explanation.

This channel seems to have been obscured in the neighborhood of Tekoa by Aeolean soils which accounts for the tardy finding of this outlet.

[Presented before the Northwest Scientific Association, Dec. 29, 1926. Paper was not listed to be read on the program but was presented in the general discussion of a paper, "Recent Drainage Changes in North Idaho and Eastern Washington", by F. B. Laney, U. of Idaho, in which he set forth evidence of a hitherto undescribed ice lobe which he made contemporaneous with the Spokane Ice to which he gave the name the Rathdrum Lobe. The paper was a summary of field work done by Laney and Anderson.]

*Hershey, Oscar H. (97).

Abstracts of Papers

presented at the
GEOLOGY AND GEOGRAPHY SECTION
of the
THIRD ANNUAL MEETING
DAVENPORT HOTEL, SPOKANE, WASHINGTON
DEC. 28-29, 1926
F. B. Laney, Chairman.

The glacial lobe of the Priest River Valley.—THOMAS LARGE.

This paper is a report of observations made in the summers of 1924, '25 and '26 while engaged in other work in this locality. Ice effects here observed agree in most respects with those of Stewart (Jour. Geol. 21: 427-430. 1913). The name, "Wisconsin Period" has been used in connection with the advances limited to valleys in this region. It is not at all established, however, that these invasions occurred at the time of the last ice invasions in Eastern America. It seems reasonably certain that this ice is contemporaneous with the moriane traced by Blackwelder and Gary in the summer of 1902, from near Lake Chelan to Diamond Lake, near Newport, Washington; that ice was also confined to lower levels and their work did not take cognizance of the well defined earlier invasion of greater depth and extent, recently called the "Spokane Ice" (Large, Science, 56: 334-5. 1922; and Bretz in various papers relating to "Scablands", etc. Jour. Geol.). Ice in the narrow valleys, Upper Priest River and Hughes Fork, eight miles south of the International Boundary, may have reached a depth of 1700 feet as shown by scratches and a narrow train of boulders on the top of a peak between these valleys directly east of the Hughes Fork Ranger Station. Till is found in quantities at the south end of the ridge separating these valleys and in the form of terraces in the valleys of creeks tributary to

Upper Priest River. Truncated ends of ridges separating these valleys are usual. A succession of recessional moraines are found crossing the valley of Priest River between the village of Priest River and Priest Lake and in the valley of the Upper River. What Stewart considered a moraine dividing Upper Priest Lake from Priest Lake seems to be composed entirely of a sand apparently derived from disintegrating granite and carried into the lakes by Caribou Creek, which comes into the valley from the east. The terminal moraine of this lobe has not been located and may have been entirely swept away by drainage through the channel of the Pend Oreille River at the south end of the Priest River Valley. It seems probably that this ice lobe was the cause of the obstruction at this point which diverted the Cordilleran (Columbia) drainage toward the Spokane Valley. On the west side of the great (unnamed) valley which may be considered a southward extension of the Purcell Trench, is a terrace which extends as far south as Lone Mountain, near Rathdrum, Idaho. Investigation is needed to establish a connection between this and the Priest River Ice.

Cirques on the north sides of all higher peaks to the north of Bald Mountain in the range on the east side of Priest River Valley give the ruggedness of skyline of this range and gave the writer the impression that at no time was this ridge covered by ice of the Cordilleran Ice-sheet. The walls of these cirques are commonly 1200 to 1500 feet, which seemed too great to have been effected since the time of the Spokane Ice. Those cirques are entirely in granite.

In discussion of this paper, Mr. Virgil R. D. Kirkham stated that he found evidences of continental ice on even the highest peaks of this range.

The Cordilleran drainage at the time of the Wisconsin glaciation and its relation to the erosion of Lake Pend Oreille. —W. A. ROCKIE AND THOMAS LARGE.

That both ice and water were effective agents of unusual potency in production of physiographic features of the Cordilleran region west of the continental divide in northwestern United States, is just beginning to be fully appreciated. The work of a number of observers in the past few years deals chiefly with the effects of water diverted by ice from the ordinary drainage channels. Some writers have not seemed to appreciate the fact that the leran Ice Sheets as given by Dawson (Ice position of the "Main Neve" of the Cordil- Age in Canada), was so placed that it blocked the drainage of both the headwaters of the Frazer and the Columbia Rivers forcing them to seek outlets through various valleys to the southward. It is frequently assumed also that the Glacial period was a time of intense cold in which all water was in the form of ice. This does not necessarily follow. The western part of the state of Washington is now undergoing a glacial period though humidity is unquestioned. It seems quite possible that much moisture in the form of rain may have fallen between the main snowfields in central British Columbia and the crest of the Rocky Mountains. This possibility together with the extent of impounded waters in ice-blocked valleys needs investigation before postulating lava outpourings to melt sufficient ice to produce water for effects which have been observed.

The southeastward movement of ice across ranges and valleys with a general north-south parallelism caused successive diversions of drainage until Lake Pend Oreille was reached* when the height of the Coeur d'Alene Mountains to the south of Clark Fork prevented further diversion around the eastern border of the ice-sheet. Dr. Davis believed that a channel to the south of Lake Pend Oreille would be found but such a channel does not exist. The water either found a way over the top of the ice or under it. The writers studying this prior to seeing Dr. Davis' paper came to the conclusion that the water had forced its way under the glacier in the lake, from the character and position of the gravel bar which divides the southwest extremity of the lake into two bays and from the character of the terrane directly to the west of this where the scourings from the lake bottom were deposited by the released waters. This rises to a height of more than 350 feet above the present lake level. Apparently the drainage was at first by the valley to the south but later, retreat of the ice from Clark Fork valley to the west released the water to that direction on a lower level and the channel to the westward from Bayview was eroded. The present outlet of the lake at Sandpoint was established still later. There is an alternative possibility, that the waters

*Davis, W. M. Annals Asso. Am. Geog. **10**, 75-148. 1920.

from the east and north followed the top of the glacial ice in the bed of the lake, leaving it at the southern end of the lake. It seems improbable, however, that so large a stream would not at some place in a distance of twenty-four miles from the entrance of Clark Fork to the southern extermity of the lake have left marked effects where it eroded or deposited sediments even on such steep mountain walls as border this lake. If the water did find its way under the ice as the writers believe this will account for the depth of the lake, though the competence of ice to erode to such depth where confined between vertical mountain walls is not denied.

The genesis of commercial oil in the San Juan, Colorado and New Mexico oil fields.—J. H. EBY.

The San Juan Basin, situated in the southwest corner of Colorado and the northwest corner of New Mexico, is a topographic and geologic Basin with its rim cmposed of the Continental Divide, mountains and highlands.

The formations are all of the Mesozoic and the lower part of the Tertiary with the Jurassic and Triassic exposed along the edges of the basin and a capping of Eocene in the center. Two formations of Marine shales in the lower portion of the Cretaceous, each over one thousand feet in thickness, rich in Kerogen, the oil component of oil shale, are the sources of the oil. Both of these formations are underlaid and overlaid by the freshwater sandstones, the most permeable of which is the Dakota at the base of the entire series of Cretaceous.

All the commercial production so far has been from the lower sandstones of the Dakota while a little oil has been found in the other standstones adjacent to the oil shale series, but no production or seepage whatever has been found in the oil-containing shales themselves. The oil shales are devoid of permeable sands through which oil can migrate.

The productive structures are the monoclinal folds and along the rim of the basin. The only source for the oil is from the overlying oil-bearing formations and the Dakota Sandstone is underlaid by three thousand feet of Jurassic and Triassic rocks devoid of oil and proven barren by a test well drilled into them.

The oil to come from the overlying shales must find its way into the underlying sandstones on the sides of the monoclines as there is no other possible means of escape. The crude oil, a 61 gravity with 37% naptha and 35% gasoline, can be explained only by the fact the more volatile oils can possibly escape from the shales by this way. In the most productive areas there is the unique occurrence of the oil-containing formation being exposed and partly eroded with the production coming from the underlying sandstone.

Some fossil studies of the Succor Creek District.—ORMA F. SMITH. (No abstract furnished.)

The recession of Grinnell Glacier, Glacier National Park.—M. J. ELROD. (No abstract furnished.)

An ancient forest on the Columbia destroyed by a lava flow.—E. M. TARDY.

This paper records a visit to a bluff near Peach on the Columbia River about 12 miles from Creston on the Sunset Highway. The silicified wood is found in a bluff or basaltic cliff about 200 feet high. Along this bluff there is a narrow ledge with small openings into which one may crawl. Both upright and prostrate tree trunks were found, some turned to silicon, others still wood. In one case a trunk 5 feet in diameter was traced upward for over sixty feet. Seventeen trees were counted along the cliff within a distance of about 250 yards. It is conjectured that the trees in evidence along the face of this cliff represent the edge of an overwhelmed forest that is probably buried farther back in this basaltic formation.

Discovery of a mammoth near Cheney.—J. W. HUNGATE.

In plowing his field a few years ago, Mr. V. H. Morgan, a farmer living near Cheney, Washington, discovered a portion of a large bone. Suspecting that it might be a bone from an extinct mammal he searched for the place where it had been uncovered but was unable to find it. A year later in the spring of 1927 he plowed up another bone. Subsequent digging revealed more bones, none of them at a greater depth than four feet. Among them were several teeth in fairly good state of preservation. One of these was sent to Mr. Oliver P. Hay, who pronounced it to be the tooth of **Elephas columbae.**

The bones of the skeleton were so badly decomposed that any attempt at restoration was impossible. They were uncovered well up on a hillside. In the lower parts of this loess indications of glacial till were found.

The most striking thing about the discovery was the fact that the bones were

imbedded in a loess, and not in low boggy formation.

Origin of the Palouse soil.—D. S. CARDER. (No abstract furnished.)

The Moyie (Lenia) overthrust fault.—V. R. D. KIRKHAM.

About three miles of this fault near Eastport, Idaho, was mapped by F. C. Calkins of the U. S. Geological Survey in 1906. About five miles of the fault in Idaho and twenty-two miles in Montana were mapped and named the Lenia fault by him at that time. He did not describe its overthrust character, however. The Bull Lake Fault in western Montana was also described by him in the same reconnaissance but it was not connected with the Lenia fault. S. J. Schofield, a geologist of the Canada Geological Survey, mapped and described the Moyie fault in 1915. This fault extends from Eastport to the Kootenay River east of Cranbrook, B. C., a distance of approximately 45 miles.

Field work by the writer in 1924 and 1925 established connections between the Moyie, Lenia, and Bull Lake faults and determined that each was part of one long uninterrupted fault which extends from the Kootenay in Canada to the Clark Fork in Montana. Its traced distance is now at least 130 miles. It is overthrust from west to east and has a vertical throw varying from 16,000 to 22,000 feet. Its plane is fairly steep and its horizontal overthrust is approximately the same distance.

The beds on the western overthrust lip are chiefly the Aldridge-Prichard formation of Lower Beltian age. The beds on the eastern underthrust side are Creston-Ravalli formation and younger although chiefly Beltian rocks. The vertical throw is the greatest at the southern end. The mapping of this overthrust fault has unusual significance in aiding in the determination of the key to Rocky Mountain structure.

Extinct glacial lakes in Boundary County.—V. R. D. KIRKHAM.

Five areas now covered by stratified silts, sands and gravels represent the outlines of temporary or semi-permanent lakes which resulted from the glacial invasion of the Pleistocene. The material was eroded from the nearby terrane and shows the usual shallow water and delta characteristics.

Kootenay Lake, which now lacks nearly 14 mlies of reaching the northern boundary of the county, extended during Pleistocene time from north to south throughout the county and undoubtedly connected with the basin in which is the present Lake Pend Oreille. Although the lake has varied in depth and altitude at various times, owing to the resistance of its dam and the fluctuation of its water supply, it has deposited stratified sediments to a depth of more than 200 feet in parts of the area. The highest level of this old lake was considerably above the 2200-foot contour, as shown by the terraces. In its last stages, Kootenay Lake was dammed at Moravia, and Deep Creek developed a drainage leading from it. The lake preserved this extent until recent times. Conversion of its southern extremity into a swamp probably occurred only within the last few hundred years.

The lake basin, reaching from Eastport into Round Prairie and down below Snyder, was dammed on the south by a resistant basic sill which has since been severed by the stream. This lake was at a higher contour level than old Kootenay Lake, but was smaller and shorter-lived. The deposits in this basin are thin, and only erosional remnants remain. The lake near Meadow Creek had a similar history and was dammed by the basic sill which now is responsible for Moyie Falls. The old lake on Boulder Creek, formed by a melting alpine glacier, is thought to have been dammed by a basic sill. The old lakes on Grass and Cow creeks were dammed by a morainal obstruction and were undoubtedly short-lived.

A PIONEER STUDENT OF GLACIAL DRAINAGE

Any student of the geology and physiography of this region might do well to begin by reading Bailey Willis' (14) early discussion of the drainage changes caused by glaciation of the region. This paper deals with the physiography of the area from Lake Pend Oreille westward to the Okanogan (spelled Okinokane), Methow and Wenatchee rivers, and from the Canadian border to the lavas of the Columbian plateau. Later work has added many details and the work of Bretz and others bring out some of the results of these drainage diversions which the earlier observers did not grasp but certainly all students of Methow, Okanogan, San Poil (San Puel), Columbia, Kettle, Colville, and Chamokane drainage areas as well as those areas lying between here and Lake Pend Oreille will profit by reading this pioneer discussion.

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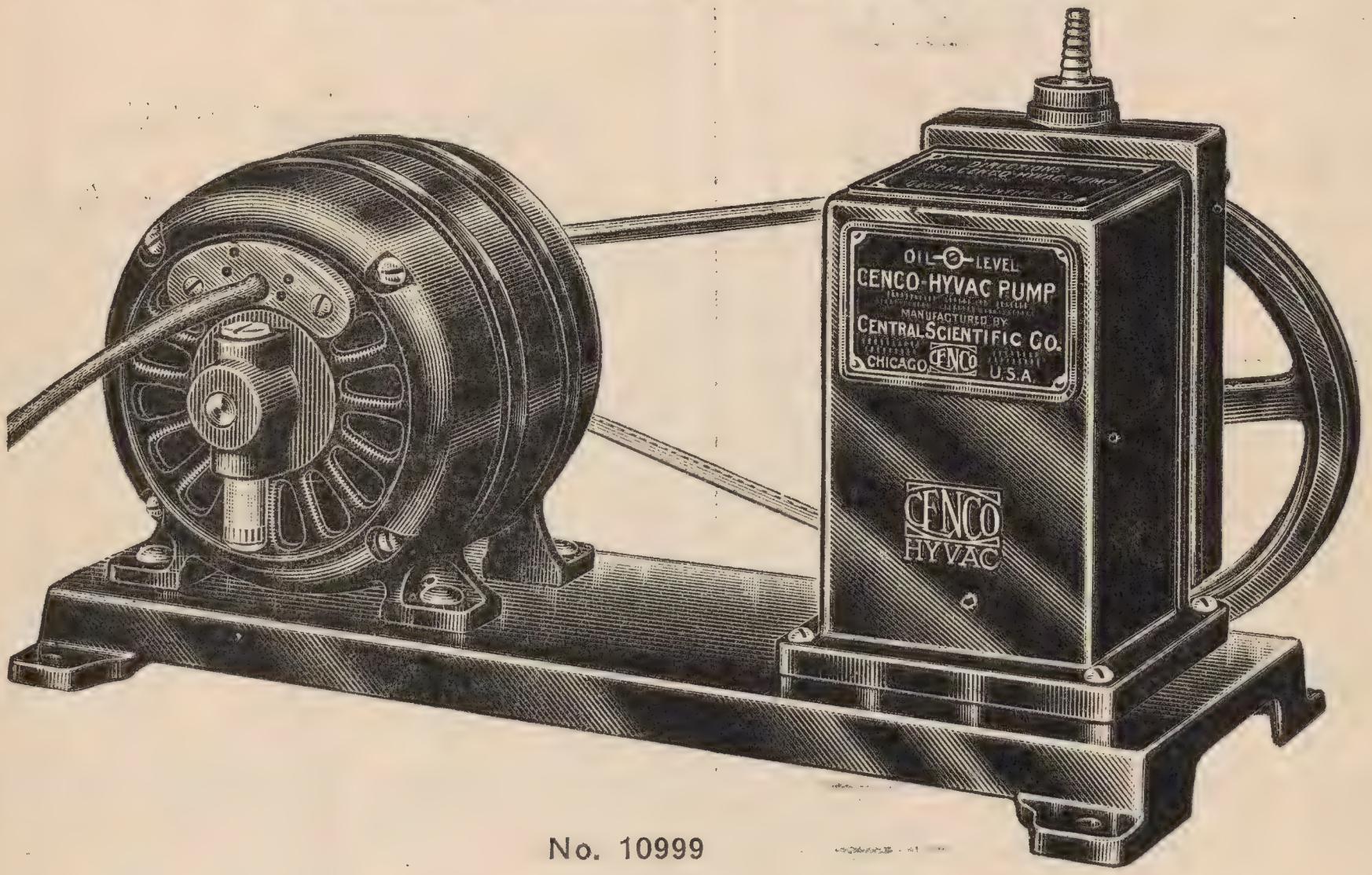

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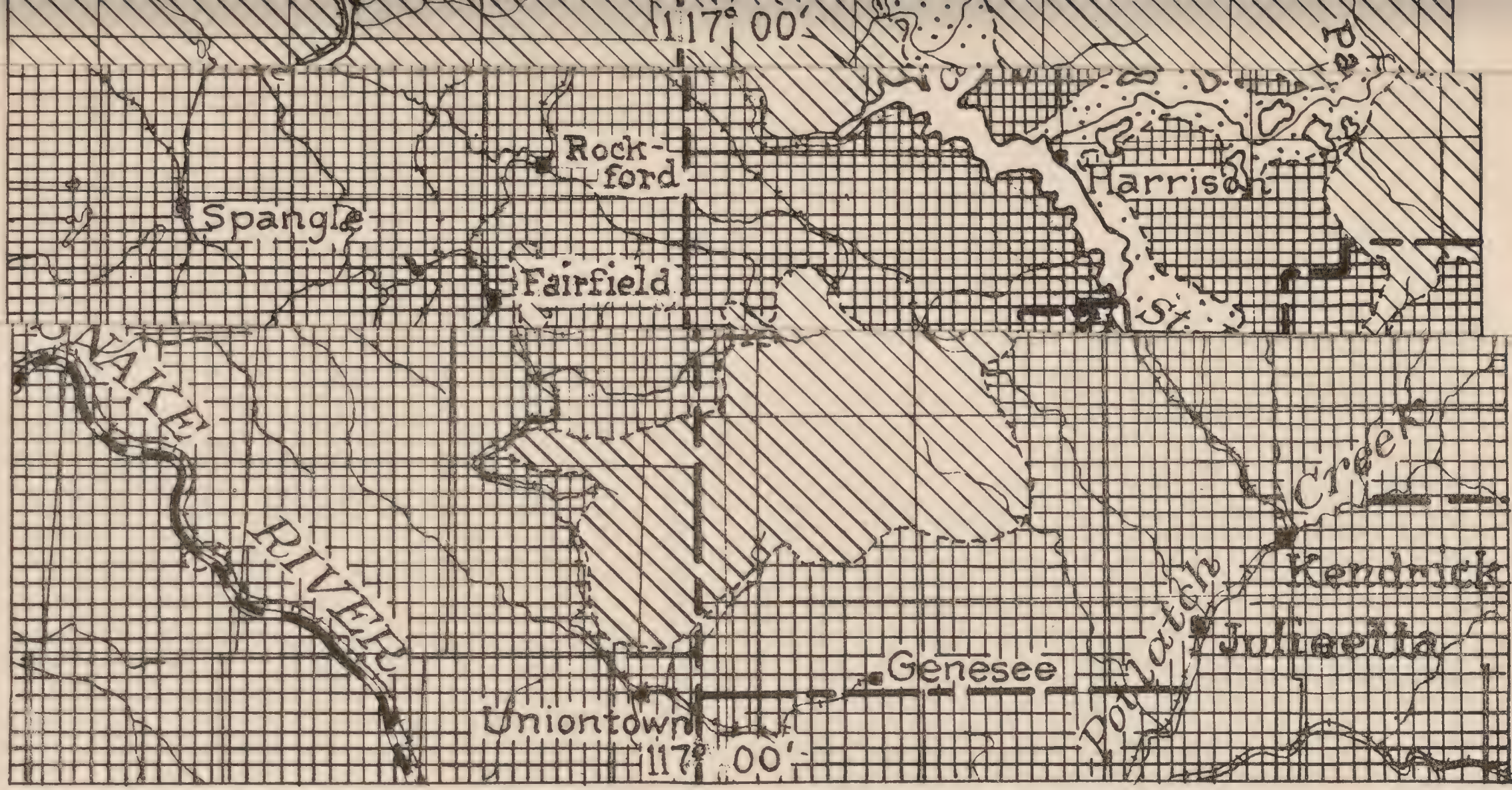

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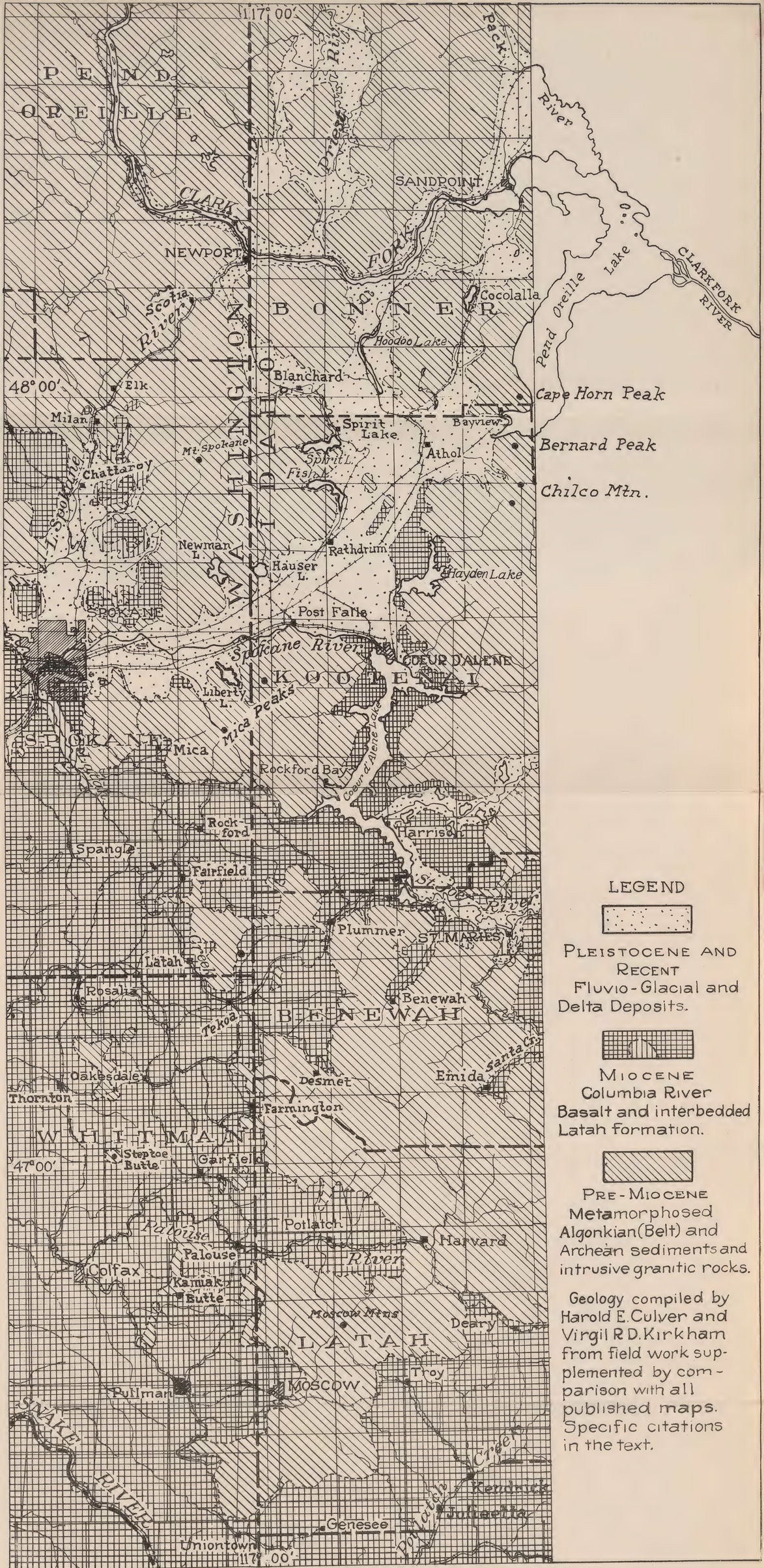

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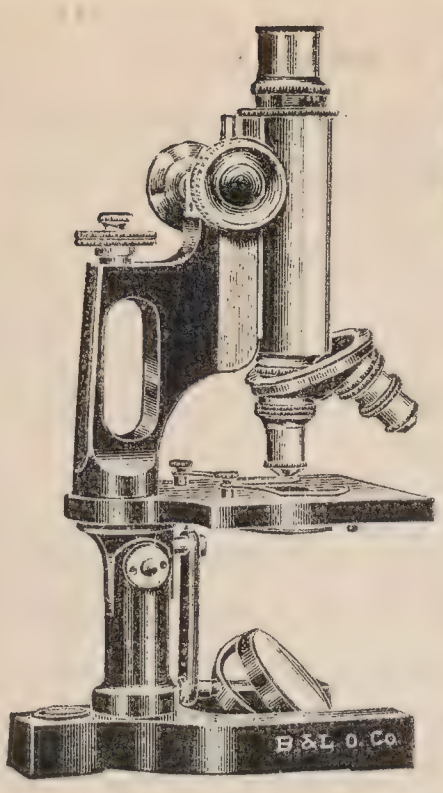

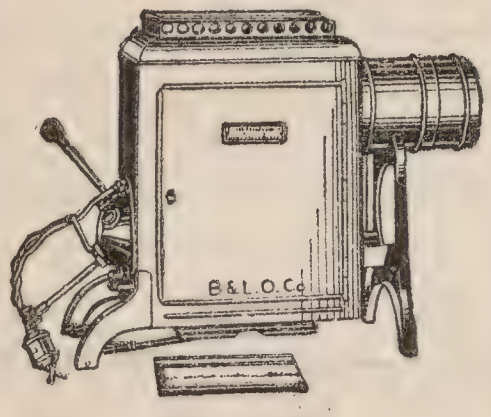

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FOREWORD

A list of the members of the Northwest Scientific Association prepared by the Secretary-Treasurer appears in this number. Members are invited to report any omissions or errors to the Secretary-Treasurer. We are to be congratulated on having such a large membership, including such excellent personnel and covering such a wide area. The present status is but a gesture of what we aspire to with the warm support of the members, and a larger list to be recruited from the field.

Section activities have been encouraging. The Section of Economics and Social Science held a meeting when Dr. E. A. Bryan gave a masterly address on the relation of each of these to the other and the need for more intensive study as applying to human relations and society. The officials are to be congratulated on their activities. The Geology and Geography Section, through its Chairman particularly and by the aid of its Secretary and the cooperation of others, presented in the June number of NORTHWEST SCIENCE a large collection of data and a map of the geology in Idaho and Washington covering an area about 48 miles east and west and 136 miles north and south with States' line running north and south exactly through its center, showing Spokane near center north and south and embracing Moscow and Pullman to the south. For this performance and wide demand for copies of the June number we are greatly indebted to those responsible for the production. The Engineering Section will doubtless be formed for the forthcoming meeting.

This brings us to the Fourth Annual Meeting which now appears best should be held during the mid-winter vacation when we hope to secure low rates from the railroads. Exact dates are yet to be determined but December 28-29 seem quite proper dates and are recommended to the attention of the Officers and Council. Definite information will be issued from the office of the Secretary.

The Officers of each Section are urged to secure material for the program which will continue the high character heretofore maintained. If I might offer a suggestion it would be that subjects which most closely affect or have to do with problems of local interest first be considered, although anyone having prepared a paper touching on any scientific subject should be invited to submit it. Items for discussion may properly be introduced but papers must have first place and should be submitted to the Secretary as early as possible. The Committee of Seven will have an interesting report to make as to the future of certain suggested activities. Submission of this report and definite action respecting incorporation will form subjects for the business meeting. The address of Retiring President C. H. Clapp to be given at the annual dinner will be the outstanding item of the entire program.

Some of the present year activities in which the officers and members participated were entertainment for the Western Reserv Univrsity Dpartment of Geology, the American Electro-chemical Society, and several notable visitors. On the occasion of the death of Dr. Charles D. Walcott, simultaneous memorial services were held at more than twenty educational institutions or other centers.

Space does not permit more than to say that the Northwest Scientific Association seems to have found a place in this community of States to draw those who are seeking truth together, which, it is hoped and expected will increase interest and knowledge in science.—L. K. ARMSTRONG, President.

Amateur Telescope Construction

By LESTER M. LIVENGOOD,
Spokane, Washington

How many of you in your early youth read the alluring advertisements of the three-foot telescope that was guaranteed to make "distanct objects appear close up", and hankered in your heart of hearts for one of them? To me this experience came early, around six or seven years of age, and found outlet in a letter that I wrote my grandmother soliciting a loan of $1.85 for a telescope. Through all the years since then I have wanted a real telescope, but have never been able to afford one. That this experience is common to a surprisingly large number of American people is evidenced by the response to the Scientific American's recent movement to encourage amateur telescope construction. That worthy magazine published one article describing the activities of a group of amateur telescope makers in Springfield, Vermont, and announced that other articles would follow if sufficient interest was shown. The editor wrote me that they had expected only a small number of replies, and were astounded to receive over nine hundred within a brief space of time. The result was that the Scientific American reprinted all the data on amateur telescope construction available in this country as well as most of a book on the subject printed in Great Britain, and today hundreds of amateurs all over the United States are at work or have completed their glasses.

My interest in this subject antedated the above movement, however, some two years, and started from reading an article in Science and Invention, wherein was described by a Californian how he constructed a 10-inch reflecting telescope. I learned afterward by bitter experience that his brief article merely touched the high spots of the art, but once the desire was aroused, the obstacles were overcome one by one. Long digging in ancient scientific documents in libraries and every other source provided the ata which I used, only a part of which on account of lack of space, can be presented in this paper.

Those who contemplate actual construction of a telescope should purchase a book that was not available to me at that time, that is to say, "Amateur Telescope Construction", from the Scientific American.

Before proceeding with details of construc tion it might be well to refresh your memory concerning the history of the telescope. Its recorded origin dates back to the beginning of the seventeenth century, wherein a Dutch spectacle maker arrived at the combination of spectacle lenses that would make distant objects appear closer. The discovery spread over the country rapidly. Galileo in Italy immediately constructed himself a telescope and in the following years progressed with the art sufficiently to build one that upset the established doctrines concerning the structure of the universe. He discovered the first four satellites of Jupiter and the rings of Saturn, and a number of things unknown to the world at that time. These telescopes were of the type most of us are familiar with, that is, the refracting type. The light passes through an object of glass and a magnifying eye-piece on its way to the eye. However, it was not until the time of Sir Isaac Newton that the reflecting type of telescope using concave mirror was developed. The early reflectors used spherical surfaces which were corrected from the sphere empirically, but according to no known laws to any particular conic section. Some mathematician developed the fundamental idea that the paraboloid would be the ideal curve to bring out rays of light at one focus, but methods for testing the paraboloid curve in the course of construction were not available, so most of the great astronomers of those days had to work with inferior glasses. When a Frenchman by the name of Foucault developed the knife-edge shadow test which served to determine the curvature of glasses within a few millionths of an inch by the most simple methods, the reflecting telescope came into its own with but one draw-back. No known method of silvering on glass was available at that time. Therefore specula were ground out of a composition material and had to be refigured every time they were repolished. It has only been since the Civil war that efficient methods have been known for silvering on glass. The result is that now glass is the universal speculum material, and when the silver tarnishes it is removed by nitric acid and a new film deposited. As you all know the reflecting telescope

has the image deflected by a second mirror suspended at an agle of 45° near the focus through a hole in the side of the tube where it is viewed with the eye-piece. The subject of telescope construction divides itself naturally into the following headings:

FIRST, GRINDING.
SECOND, POLISHING.
THIRD, FIGURING OR PARABOLIZING.
FOURTH, SILVERING.
FIFTH, THE MOUNT.

We will take up each heading in its proper order.

GRINDING

It is apparent that grinding a curve out of thick pieces of glass correct to a few millionths of an inch is a thing that looks almost impossible. However, there is a fundamental law of nature which most of us overlook which solves this problem very neatly and by the simplest methods. If two circular discs of glass be ground together with an abrasive between and with a certain length and combination of strokes, one of the glasses will become convex and the other concave, and if the stroke is one-third of the diameter the curve will approximate a true sphere. The physical reasons for this are beyond the time permitted by this paper. The first things to do therefore is to secure the glass for a ten-inch mirror. I used two discs ground circular, one ¾" thick and the other, which was to become my mirror, 1½" thick. These were of plate glass free from bubbles and serious scrtaches and were obtained in Portland, Oregon. The thinner glass was cemented to the head of a barrel which itself was arranged at the proper height and filled with rock for rigidity. The cement used was black boat pitch well leveled up. The thicker glass had a handle likewise cemented to one side in the center. I proceeded then to start the rough grinding, using No. 70 Carborundum. A coarser grade can be used if grinding is checked enough to insure that you are not getting beyond your curve before you know it. The carborundum is mixed with water into a thin paste. A spoonful will last about five minutes. The grinding motion consists of short to and fro strokes which may be more than the one-third diameter called for to get a sphere in order to deepen out the center quickly. The correct stroke later in fine grinding will bring the curve back to the sphere. The stroke consists also of twirling the glass in the hand and walking around the barrel continuously. This prevents zones and streaks and insures a uniform curve. In order to test the curvature one first determines in advance the focal length desired, which for easiest correction and best results should be about eight times the aperture of the glass. This would mean for a ten-inch glass, eighty inches. Since the focus is half of the radius of curvature the section of the sphere which we must cut out of this glass will have a radius of 160 inches. So then we construct with a long piece of wood and a couple of nails and a piece of tin a small section of a sphere of this curvature which we use as a template to test the curve of our grinding. When our curve deepens so that the template begins to fit, but not quite, we quit using the coarse carborundum, wash all the parts up carefully to remove the coarse grains and start using finer carborundum. Any series of grades fairly spaced in size up to the finest is all right. I used 220 for the next spell and in this spell attempted to bring the curvature to very close to the desired focal length. As it approaches the proper place the glass when covered with water will reflect a focal point of light the distance of which can be measured fairly accurately. When the curvature is approximately right with the 220 grade, it is discarded, and about a half-hour's grinding with each of 400, 500 and 600 grades of carborundum should follow, washing off each grade before the next is used.

Since carborundum makes a sharp and deep pit, emery should be used as a final abrasive in fine grinding and should be elutriated so that you have various grades running down to a 24-hour settling for the last grade. This broadens and shallows the pits and makes polishing much more easy. The next stage is polishing, for our glass at the end of fine grinding will be of translucent ground glass appearance. Before starting the polishing a miscroscope of about 1 inch focus should be used to see if the pits are of uniform depths, otherwise the polishing will bring out the defects in tragic relief later on.

POLISHING

We polish the mirror on a bed of pitch which is made by pouring melted pitch of a hardness that will just indent about ¼ inch by moderate pressure of the thumb nail on the convex surface of our thin glass which we will call the tool. This pitch while warm is held in place by a paper band wrapped around the circumference of the tool. As it is soft but not running freely, the mirror glass, previ-

ously warmed and its surface slopped with warm, soapy water, is placed on the soft pitch and moved back and forth until the pitch assumes the curvature of the mirror and remains more or less firm. This pitch bed must be laid off in little squares about 1¼" part like a waffle iron, with a ⅛-inch groove separating each square. The purpose is to permit the free access of air and the equal distribution of the polishing rouge which we use for the polishing abrasive. It is a high grade of jeweler's rouge and should be elutriated and even kneaded in a muslin bag under water to eliminate grit that usually comes with it. These squares may be cut either by marking the mirror when the pitch is not quite hard or after it has cooled, but in any case it is a sticky job.

The mirror should be in perfect contact with the pitch bed before polishing is started and should rest on it several hours under a weight with plenty of rouge between in order to be sure of this point. Polishing is carried out with the one-third stroke and is a long and tedious process. If the finest grade of emery has been used for fine grinding and there are no irregular pits, from nine to twelve hours may polish a ten-inch glass. Otherwise it may run much longer. A microscope is used to check the polishing, as the mirror must be brought to a perfect polish. When the mirror is perfectly polished, which means that it is as clear as the clearest window glass and with no pits in it, we are ready for parabolizing, or figuring as it is called.

PARABOLIZING

The curvature that we are seeking for a reflecting mirror is a section of a paraboloid of revolution. As you all remember the parabola is the conic section which has the faculty of bringing all rays parallel to its axis to a common focus. If we start out with a perfect sphere then our finished paraboloid may be made either by deepening the center of the sphere and more gradually toward the edges, or flattening the edges of the sphere and decreasing the flattening toward the center. Practically the first method is used.

Since the parabola has a radius of curvature increasing from its vertex outward, it will be apparent that we will have to have some test whereby we may know the radius of curvature of any zone of our mirror from the center and also we must know in advance what the exact length of this radius should be. Thanks to the mathematicians we have a formula that expresses this exactly. If "R" equals the semi-diameter of the mirror, and "F" equals one-half its radius of curvature as a sphere, then this formula is $2F + \frac{R^2}{2F}$. Since we are going to deepen the center of the mirror, the edges of the mirror will be just 2F in radius or in our theoretical mirror of 10 inches aperture and 80 inches focal length, this will be 160 inches. The central zone of the mirror, however, will be $160'' + \frac{25}{160}$ or 160.15 inches. It is apparent that no mechanical measuring device could tell us what we want to know, but thanks to the Frenchman Faucault, we have an easy way of checking our curvature to about one-fourth of a wave length of light or five-millionths of an inch. If we construct an artificial star by using a metal chimney on a small kerosene lamp with a miniature pin-hole in it, and set this pin-hole at the exact center of curvature of the spherical mirror, it is apparent that the rays of light would come back on themselves and reenter the pin-hole, but if the pin-hole was displaced sideways slightly in the same plane as the center of curvature, that these same rays of light would cross at equal distances on the other side of the center of curvature. If we now put one eye close to where these rays should cross and move in front of the eye a knife edge exactly in the same plane as the center of curvature, the light reflected by the mirror will appear to die out evenly all over as the knife edge is moved from left to right, assuming that the lamp is on the right of the eye. Now if the pin-hole and the knife edge should be inside the center of curvature, the knife edge will cut the schematic rays of light before they cross at the center of curvature and a shadow will appear to cross the mirror from left to right, whereas if we are outside the center of curvature the reverse will be true and the shadow will appear to have crossed from right to left.

If the mirror is truly spherical it will give the appearance of a highly illuminated flat surface when the pin-hole, eye and knife edge are at the exact center of curvatur. Assuming that we have a true sphere, the next problem is the parabolizing. First we calculate how much deeper the center of the zone must be than the outside zone for a section of the parabola of the diameter of our mirror and of its 160-inch radius of curvature. Next we cut a

disc of pasteboard the same size as the mirror and out of it remove a 1½-inch or 2-inch circle in the center and two diametrically opposed marginal sections of about an inch in width. Then we lengthen the stroke of our polishing from one-third to even two-thirds of the diameter and proceed with our polishing, stopping to test every ten or fifteen minutes. With our diaphragm over the mirror in testing we keep up this method of polishing out the center more than the edges until our test shows the two outside zones darkening equally and instantaneously with the knife-edge test at a distance $\frac{R^2}{2F}$ farther out from the mirror than where the center circle of our diaphragm has its light extended uniformly by the knife edge. The stroke must be varied to meet the conditions as they arise. The general curve of the mirror when parabolized will appear somewhat like a "life-saver" or a dough-nut, with a depression in the center. The central portion of the ring of the dough-nut, as we will call it, must be at about one-third of the diameter of the glass. There are a number of different strokes that will produce parabolization and also it can be produced by cutting away the pitch tool squares progressively from the center outward. One important point must be always kept in mind in testing, that is to let the glass cool off thirty minutes after each period of polishing before testing, as a glass just off the tool may show a true parabola, but an entirely different curve when it is cooled. The heat of the hand will raise on the surface of the glass relief like a cameo that is plainly visible by the knife-edge test, and all precautions should be taken while polishing to have a uniform temperature and freedom from dust. The tendency is to over-correct a mirror, which means that we get a hyperboloidal curve instead of the paraboloid. It is very difficult to work backwards from the former to the latter as I have just experienced in my second glass. Fifteen minutes of over-polishing has cost me many hours of hard labor to get back to the sphere from which I can work down-hill again toward paraboloid. Our next problem will be that of silvering.

SILVERING

Unlike the mirrors with which we are familiar the telescope is silvered on the curved front surface and the job of silvering is a delicate and fussy one. There are several formulas for the process which can be found in Circular No. 32 of the Bureau of Standards. I used silver nitrate which had been saturated by ammonia and precipitated silver with formaldehyde. The sine qua non of silvering is cleanliness. The glass must be thoroughly cleaned with nitric acid and according to some formulas, with stannous chloride, all of which must be thoroughly removed by distilled water. The mirror is made its own silvering basin by a strip of paraffined paper tightly wrapped around its edges and is kept covered with distilled water until the silvering solution is ready. After mixing the two solutions that are required and pouring them on the mirror it is but four or five minutes until the silver is precipitated in a beautiful, brilliant silver surface on the glass. When the precipitation begins to get muddy the solution is poured off and the mirror thoroughly rinsed and swabbed lightly with cotton, after which it is set on edge to dry. After the film has dried in a warm place for a day or two the next process is to burnish this already brilliant surface. This is done by chamois skin over a piece of cotton, rubbing with circular strokes from the center outward. After the preliminary burnishing, a slight amount of extremely fine rouge is put on the burnisher which finishes the process. We now have our main mirror, but we will also have to have a diagonal flat mirror to throw the image at an angle of 45 degrees through the side of the tube where the eyepiece will be.

A small piece of thoroughly clear plate glass can be cut to the proper size which can be calculated practically by drawing the triangle of the aperture and focus of the mirror on a piece of paper and drawing a diagonal at 45 degrees at about ten inches from the focus. Theoretically it can be figures out, as I did it, by a combination of analytical geometry and trigonometry, but this is not necessary. A right angle prism can also be used with even better satisfaction, as it does not require silvering. We now have the fundamentals of the telescope, and all we need is the mount, which simple as it may seem, presents many obstacles.

MOUNTING

A workable mounting for a ten-inch telescope presents mechanical problems that require the assistance of the metal worker and somewhat of an outlay in money unless we can adopt things for this purpose that were not intended therefor. In order to reach all parts of the heavens we should have what we call the equatorial mount,

which requires two sets of axes on bearings at right angles to each other, one of them being fixed to the base and lined up with the latitude of the place and the other carrying the telescope tube in a cradle. An ingenious amateur in Texas worked out a method of using Ford parts for this purpose and I followed his plan. First I set a concrete pedestal in the ground made out of a drainage tile filled with concrete, on which was cemented a triangle-shaped block of concrete carrying an iron tube which I sighted on the North Star before I let the concrete set. Through this tube one of the Ford axles goes and is adjusted for parallelism by two sets of four set screws. The telescope tube is made out of heavy galvanized iron, which any tinsmith can turn out at a very reasonable price, of a length of about eight or ten inches greater than the focal length and one inch greater in diameter than the mirror. The mirror is mounted at the bottom and in a cell with four push and pull adjusting screws so that the image or focal point can be thrown outward along the exact center axis of the tube and will, when the small diagonal mirror mounted on cross wires is centrally placed, throw the image out through the side through a hole cut for that purpose in which is mounted the eye-piece with its draw-tube. The whole tube is mounted in a cradle at the end of the second of the Ford axles and properly balanced so that it can be turned in any direction in the sky with the slightest motion One of the simplest, yet practically the most difficult things to obtain was the rings for the tube, as they must be exactly circular in order to turn smoothly in the cradle bearings. I found automobile brake drums of the proper size and had rings turned off of these. The metal was so tough that it was an expensive job.

Eye-pieces can be had for a few dollars apiece so that it does not pay to attempt to construct one, although it is a simple matter to make them if one can get hold of plano-convex lenses of the proper curvature. We will need not less than three eye-pieces, say of one inch, one-half inch, and one-fourth inch, equivalent focal length. Since our mirror is to have a focal length of 80 inches, a quarter-inch eye-piece will give the magnification of 320 diameters and a one-fifth inch will give a magnification of 400 diameters, which powers are much higher than those ordinarily used. The powers around 50 and 100 are the most satisfactory under average seeing conditions.

CONCLUSION

There are a hundred points in this description that could well be elucidated except for lack of time and space, for some of the simplest appearing things present the knottiest problems; for example, the hardness of the pitch, the easiest way to make a pitch bed so as to get contact with the mirror, the necessity of cold pressing before polishing each time, and a number of other pitfalls, can only be mastered by experience, unless the amateur carries in his head while constructing his first mirror more than most of us do. Any person seriously interested in constructing a telescope as I have described, should not fail to get the small book entitled "Amateur Telescope Construction" recently published by the Scientific American Publishing Company and which was not available at the time I built my first mirror.

Prof. H. P. Barss, head of Botany and Plant Pathology, Oregon Agricultural College, is spending the year at the University of Wisconsin doing research work.

Dr. Raymond Kienholz of the Botany Department of Illinois University spent the summer doing ecological work on wild Ribes in the Notrhwest for the Office of Blister Rust Control.

The threatened invasion of White Pine Blister Rust into the great White Pine area of Eastern Washington and Northern Idaho from the known infections near Nelson, British Columbia, is now a fact. White Pine Blister Rust has been found on currants near Colville, Washington, in Stevens County, near Cusack in Pend Oreille County, Washington. Infection has been found on white pine in the coast region as far south as Mt. St. Helens in Washington and in Hood River valley in Oregon.

Dr. J. Harlan Bretz, Department of Geology, Chicago University, spent his fourth season in study of the geology of the Columbia plateau. As before he was accompanied by students. Travel the first season was on foot. The second season an old Ford was secured. The third and fourth was in a Dodge touring car and in the fifth an Essex was added to the Dodge. Five students accompanied Dr. Bretz while his family spent the summer at Rolling Bay, Washington. Dr. Bretz reports that this summer has given results more convincing concerning the "Spokane Flood" than any previous work.

Abstracts of Papers

presented before the
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at the
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THE LEWIS AND CLARK HIGH SCHOOL, SPOKANE, WASHINGTON
APRIL 10 AND 11, 1925

MEDICAL SECTION

What the public should know about cancer.—FREDERICK EPPLEN. (No abstract furnished.)

What the public should know about diseases of the ear, nose, and throat.—O. M. ROTT. Published in Volta Review, Oct., 1924.

The prevention of goitre.—EDWARD S. JENNINGS. (No abstract furnished.)

Recent advances in medical science.—GEORGE A. DOWNS. (No abstract furnished.)

BACTERIOLOGY SECTION

The use of dyes in the treatment of anthrax septicemia.—E. A. RODIER.

The value of dyes in the treatment of certain types of septicemia suggested that they might be of value in anthrax septicemia.

The epidemic of anthrax septicemia occurring in a band of sheep offered an opportunity for practical experimentation.

The first eight sheep to show symptoms were not treated and all died within twenty-four hours. Eleven other sheep became infected. Seven of them were injected intravenously with methyl violet (7 mg. per kilogram body weight), and the other four with the same amount of acriflorine. All but one of the eleven sheep recovered. The one dying was prostrate when injected with the dye. The results indicate that dye therapy should prove of value in controlling anthrax in stock.

A comparison of the oral and subcutaneous methods of immunization to typhoid fever.—LAVERNE BARNES.

A brief review of Besredka's work is given and the differences between his technic and the technic in the present work pointed out.

Results from two types of typhoid vaccine prepared in one case in the ordinary way and in the second case by a longer period of incubation of the organisms are given.

From fifteen to twenty injections per os of each vaccine were given to each rabbit, the total amount administered being 140 cubic centimeters.

Following these injections, four additional subcutaneous injections were given to get a comparison of the Widal agglutination titers resulting from each method.

The results, so far, seem to indicate that the oral method of immunization to typhoid fever can be used to a practical extent and that the immunity produced in this way is of the same type as that produced by subcutaneous injections.

The results do not indicate a marked superiority of the subcutaneous method over the oral method.

The effect of certain triphenylmethane dyes on the nodule bacteria.—C. S. VANDECAVEYE.

Preliminary experiments with basic and acid dyes of the triphenylmethane group were conducted with pure cultures of *B. radiobacter* and *Rhiz. leguminosum* of alfalfa. Suitable liquid media varying in reaction from pH_3 to pH_9 and containing approximately 9,000,000 bacteria per c.c. were used. The basic dyes were gentian violet, methyl violet and crystal violet added in a concentration of 1 to 500. The acid dyes consisting of acid fuchsin and rose bengal were used in concentrations of 1 to 100. Samples of these treated suspensions were freed from dye and plated at intervals of 5, 10, 15, 30 minutes and 1, 2, 4, 6 hours exposure. At these same intervals dye-free samples were placed in liquid cultures to study the bacteriostatic effect of the dyes.

The results so far obtained showed that pure cultures of *B. radiobacter* are less resistant to these dyes than *Rhiz. leguminosum* of alfalfa. This difference was much more pronounced in the acid dyes than in the basic dyes.

The basic dyes, although used in lesser concentrations, showed greater antiseptic

power than the acid dyes. This was especially true with gentian violet.

There was a marked bacteriostatic action from all the dyes. This action was greater with basic dyes than with acid dyes.

The antiseptic power of basic dyes increased in media with reactions of increasing pH, and that of acid dyes increased in media with reactions of decreasing pH, the maximum being at pH_9 for the former and pH_3 for the latter. At pH_5 all dyes showed little antiseptic power after six hours exposure.

These results seem to indicate that in certain respects these nodule bacteria behave much like proteins in that they reacted with the acid dyes on the acid side and with the basic dyes on the alkaline side of the isoelectric range. This isoelectric range seems to be somewhere around pH4.5 to 5.5.

Notes on dairy bacteriology.—L. A. BURKEY.

Market milk from fifteen different producers was analyzed by means of the culture plate method and the Gerber fermentation test. Analysis was made on the night and morning's milk from each producer every two weeks for six months. Each time the results of analysis with suggestions for the improvement of the milk were sent to the producer. The suggestions were prepared from the study of the number and kinds of bacteria shown by the tests. There was a rapid improvement in the quality of the milk during the six months' period. In many cases the number of bacteria was reduced from over a million to five thousand per cc. The number of bacteria in all the samples was reduced to only a few thousand per cc. This method of analysis did not improve the fermentation of the milk but in some cases it became worse. It may then be considered that the culture plate method by itself is not an adequate method for determining the quality or the healthfulness of the market milk. It was impossible to determine the value of the fermentation test. Undoubtedly this test gave a close indication, with the aid of the plate count, of the actual conditions under which the milk was produced. An inspection of the dairies showed the conditions to be the same as was anticipated from the tests. It was not determined why the milk did not improve in fermentation as well as in numbers of bacteria. The results show that improvement was made in the cooling process and in the carefulness with utensils more than with the milking conditions. There is a possibility that the fermentation test is not useful with low count milk since the proportion of lactic acid bacteria to the gas formers would be much less than on milk showing a higher count. The presence of spore-formers in low count milk also disturbs the fermentation test.

Class work with *Streptococcus lactis* has shown that this organism when growing in milk is very resistant to pasteurization temperatures, to gentian violet, and to the action of B-K (the chlorinated lime preparation) which is used in the sterilization of milk utensils. These results indicate that the pasteurization of milk does not materially injure the desirable flora of milk and that the use of B-K may be less important than is frequently thought. *B. coli* organisms are less resistant to all of these conditions.

Dormancy in bacteria.—VICTOR BURKE.

The latent period or period of quiescence of viable bacteria under optimum growth conditions have been described under two terms, "lag" and "dormancy". The term "lag" is used to designate the latent period of a few hours shown by a transplanted culture during which few or none of the bacteria multiply. Dormancy is used to designate the prolonged quiescence of a few cells of the transplant after the majority have multiplied. Thus in bacteriological literature the two terms have a slightly different meaning. In botanical and biological literature the term dormancy is used to denote periods of quiescence or of rest of reproductive cells and of full grown plants and animals. The lag shown by bacterial transplants has been the subject of considerable investigation and discussion. The dormancy of bacteria, while considerably more important than lag as an interfering factor in bacteriological research, has until recently escaped observation and investigation.

Experiments conducted at the State College on non-spore-bearing and spore-bearing aerobes indicate that dormancy is characteristic of many spores of bacteria. These experiments justify the following conclusions:

CONCLUSIONS.

1. Vegetative cells of non-spore-bearing bacteria may remain dormant for a number of days after the initial lag of the transplant. Cells of *Bacterium coli* were found to remain dormant for 16 days.

2. Spores of common aerobic bacteria may lie dormant for months under favor-

able growth conditions. Spores of *B. subtilis* were found to lie dormant for 32 days and of *B. megatherium* for 90 days. There is no evidence that this represents the limits of dormancy for the spores. A large majority of the spores develop in four or five days.

3. Dormancy and lag represent delayed germination of viable bacterial cells under favorable growth conditions. They are not identical phenomena and are probably due to different causes. They appear to be analogous to types of delayed growth found in higher plants.

4. Dormancy has an important bearing on the treatment of infections. Spores are highly resistant to disinfectants. They lie dormant in wounds for longer periods than the applied disinfectant is effective and then germinate and thus account for a recurrence of an infection in a wound once thought to be sterile.

5. Dormancy must be considered a factor in infection. It reduces the chances of infection by reducing the number of organisms that would otherwise start to grow at one time. If dormant for a sufficient period the organisms will be excluded by the body before development takes place. Since the cells begin to multiply at different times the body has an opportunity to initiate defensive reactions before all the cells develop.

PLANT PATHOLOGY SECTION

Some experiences in fumigating potatoes and tomatoes with hydrocyanic acid gas.—B. F. DANA.

Greenhouse fumigation with cyanide was carried out using a little more than the maximum recommended in the standard formula, eighteen ounces of sodium cyanide being used for ten thousand cubic feet of space. Two such fumigations were given without injury. A third two weeks after the second caused excessive injury to tomato and potato plants.

Young plants showed first a water-soaked condition, were somewhat darker green than normal and soon drooped and died. Older potato and tomato plants were checked in growth and in a few days developed a characteristic leaf necrosis. The base of the leaflet appeared most sensitive and the portion at the margin received the greatest injury, although some internal spots also occurred. The affected portions lost their color and the tissues became papery in appearance.

No varietal variation was noted in the potatoes. The plants remained inactive for a period of about two weeks, after which new vigorous shoots appeared from the axils of the lower leaves. It was not possible to determine the factors which were responsible for the extreme injury.

The blister rust situation in the Pacific Northwest.—C. R. STILLINGER.

The disease is known to occur in all of the coast region of British Columbia and extends into the interior as far east as Revelstoke, Beaton, and Nelson, B. C. It also is established in the coast region and in the Okanogan region of Washington. No extension of this area was discovered during 1924. The work in the west has been organized into projects which it is proposed to finish in ten years. The eradication of the cultivated black currant has been completed in practically all of the white pine belt and is being carried on in the white and sugar pine belt of Oregon and California. Quarantines are being rapidly enforced. During the last season 7880 acres of white pine type in northern Idaho were eradicated at a cost of about $1.63 per acre. Investigations of the susceptibility of Ribes indicates that wild black currant, *Ribes petiolare,* and the white-stemmed gooseberry, *Grossularia inermis,* are the most susceptible of our wild species in the white pine type. The possibility of the destruction of wild Ribes by means of chemicals is being investigated. Also a determination of the ecological habitat of the different species of Ribes is being made. All control work is still in the experimental stage.

Photographing some specimens illustrating plant diseases.—B. F. DANA.

Satisfactory photographing of diseased specimens is greatly facilitated if not dependent upon the use of a stand such as is illustrated by Heald in Trans. Amer. Mic. Soc. 31: 199-200. 1912. By the use of this stand or similar stands which may be purchased on the market the material to be photographed is placed flat on a glass plate and suitable backgrounds may be placed beneath the glass which is raised about six inches from the background.

Green leaf specimens with brown or black spots may be first treated to remove the chlorophyll by soaking or boiling in alcohol. They will become very brittle but this can be easily overcome by diluting the alcohol with water after the treatment until the leaf assumes a pliable condition. The spots become very conspicu-

ous on the decolorized leaf and show excellent contrast in a black and white print.

Contrast in a specimen may be increased by whitening the ground work of the specimen with ammonium chloride fumes produced by drawing ammonia and hydrochloric acid fumes together and projecting the white chloride fumes on the surface of the specimen. Sclerotia of Rhizoctonia on a potato tuber are made to stand out clearly by this process. It may be adapted to other specimens.

Opaqueing of negatives, retouching of prints and other processes known to the technician are of great value in the preparation of photographs for reproduction in scientific papers. The need for such diciphering of subjects, negatives, and prints is evident in a large part of our scientific literature.

Resistance of certain tomato varieties and selections to western yellow blight.—C. W. HUNGERFORD. (No abstract furnished.)

Some fungi associated with a canker of the evergreen blackberry.—F. D. HEALD and CARL SPIEGELBERG.

Cankers on the evergreen blackberry from a plantation at Burlington, Washington, yielded three different fungi when studied by means of cultures from the affected tissue:

Coryneum ruborum Oud., *Phomopsis* spp. and an unidentified fungus which remained sterile. All the organisms were tested for pathogenicity by inoculations into growing canes, but all except the *Phomopsis* spp. gave negative results. In addition to invading the healthy tissue of the blackberry, the Phomopsis was active on *Rosa* spp. and caused a rot of citrus fruits.

Coryneum ruborum sporulated abundantly on various media, 2% dextrose plus ten and prune agar proving superior to other media. Spores from cankers averaged 5 x 12 microns, but when produced in cultures were somewhat larger, those on prune decoction, for example, being 6.53 x 15.82 microns. The optimum temperature for growth was about 25°C., the minimum close to 0°C. and the maximum between 30 and 32.5°C.

The *Phomopsis* spp. appears to be distinct from the species previously described on *Rubus* spp. and also differs from *Phomopsis citri,* which it resembles rather closely. The A-spores or pycnospores measured 1.2-3 x 3-7.25 with an average of 1.66 x 3.26 microns; the B-spores or stylospores 20-60 x 3 microns with an average of 20-30 microns. Spores taken from a dry cane four months old germinated readily. The optimum temperature for growth was 30°C., the maximum 32°C., and the minimum 6°C.

Hosts for Rhizoctonia in Washington.—B. F. DANA.

Included in "The Rhizoctonia Disease of Potatoes" published as Wash. Agr. Exp. Sta. Bul. 191: 1-77. 1925.

Seed treatment for the control of Rhizoctonia in 1924.—J. M. RAEDER.

Published in full in Idaho Agr. Exp. Sta. Research Bul. 4. 1925.

Progress report on the study of mosaic and leaf roll of potatoes in Idaho.—C. W. HUNGERFORD and J. M. RAEDER. (No abstract furnished.)

What the virus diseases mean to the potato growers of Washington. — G. L. ZUNDEL.

One of the outstanding problems to be solved by the potato growers of Washington is the control of such virus troubles as mosaic, leaf roll, spindle tuber and witches' broom. This, at the present time, is a major project in the Extension Service. This work has been in progress for three years and the following examples will illustrate the damage done by this group of diseases and also means of control by the use of high grade or certified seed. During the fall of 1924 it was found that in Wahkiakum County potato hills affected with mild mosaic weighed 14 ounces. Another hill of potatoes affected with the final stages of rugose mosaic weighed 10 ounces, while the production of a healthy hill from the same field weighed 2 pounds, 6 ounces. About 65% of the hills in this patch were affected with mild and severe mosaic so that it meant there was a reduction of four and one-half tons per acre.

In Spokane County a man who planted high-grade Early Ohio seed harvested 50 sacks per acre. Another portion was planted with common Early Ohio seed which was much affected with virus troubles, with the result that he harvested 6 to 14 sacks per acre. Another farmer in Walla Walla County planted most of his potato field with certified seed and received a yield of 450 pounds per row, which graded 80% U. S. No. 1. A few rows of potatoes planted with his own common seed yielded him 50 pounds per row and graded 10% U. S. No. 1. In each case the rows were the same length.

During the summer of 1924 Mr. J. Howard Jones of Waterville had two patches of potatoes. Two acres were planted with certified Netted Gems which yielded him 75 sacks per acre which sold in the field at $2.00 per hundred. A nearby field planted with his own seed, 100% mosaic, was not worth harvesting.

On Badger Mountain in Douglas County, Mr. Frank Brooks planted 450 pounds of certified Netted Gems and harvested 65 sacks which sold at $2.50 per hundred. He also planted 1540 pounds of his own seed and harvested 110 sacks which sold for $2.00. This means that for every hundred pounds of certified seed used he secured a yield of 3660 pounds while for every hundred pounds of his own uncertified seed he secured a yield of 714 pounds.

A demonstration during the season of 1924, where one carload of certified seed was used in Spokane County in comparison with common seed showed that certified seed yielded on an average of 73.6 sacks per acre while uncertified seed yielded on an average of 50 sacks per acre.

The witches' broom of the service berry.—F. D. HEALD and RODERICK SPRAGUE.

A sooty mold of the Cladosporium type associated with a witches' broom of the service berry is common throughout the northern part of the United States and Canada. The ascigerous stage of the parasite was first named *Sphaeria collinssii* by Schweinitz in 1834, later changed by Von Thumen to *Dimerosporium collinsii,* and finally referred to as *Apiosporina* by Von Hohnel, in 1910.

The old witches' brooms are of two types: (a), the compact, short, thickly branched typical form; and (b), the looser open type. The leaves on the witches' broom are small, narrow, yellowish and covered on the under side except the main veins with the dark olive sooty mold, the Cladosporium stage. The leaves dry up and fall off in early summer. The fungus persists by an internal perennial mycelium which was demonstrated in the buds and primary cortex of infected twigs. Dissections of tissue treated in 10% caustic potash were more satisfactory for showing the internal mycelium than fixed and stained microtome sections. The conidia were germinated in the early spring but after the middle of June resisted all attempts to germinate them on various media.

The ascigerous stage begins to form in mid-to-late summer, maturing later on the old fallen leaves. It consists of small, globose, ostiolate perithecia, seated side by side in the subiculum covering the lower surface of the leaf. The ascospores are two-celled with the lower cell much smaller than the upper. Studies of the morphology and parasitism of the fungus, have shown its characters to be those of the Sphaeriales, rather than those of either the Dothidiales or the Perisporiales, thus confirming the work of Von Hohnel. The name of the parasite should therefore stand as *Apiosporina collinsii* (Schw.) Von Hohnel.

In the Palouse region the witches' broom of the service berry is found mainly in moist shaded places such as occur along streams or north hillsides. The conidial stage is always produced in abundance, but the ascigerous stage is produced sparingly in dry seasons.

CHEMISTRY AND PHYSICS SECTION

The teaching of organic chemistry.—J. A. KOSTALEK. (No abstract furnished.)

Quartz fibers and their uses—THOMAS M. DAHM.

Quartz fibers may be made by the bow-and-arrow method in which one end of the rod is fastened to an arrow which is fired when the heated mid-point of the rod has reached the proper temperature. A clean flame, such as that obtained with the smallest tip of an oxy-acetylene welding outfit, may be made to blow fibers of almost any desired thickness from 1 to 10 microns by proper manipulation. Such fibers are used to suspend sensitive galvanometers and electrometers. When silvered or gold-plated by the "cathode-spray" process, they are used to suspend Compton electrometers and as the moving element in string electrometers and in most types of string galvanometers which are much used in the diagnosis of heart conditions from the photographs of heart currents obtained by the electrocardiograph.

Phenolic oxidation.—ARTHUR LEVINE. (No abstract furnished.)

Some abnormalities in the separation of alkaline earths.—ALICE G. PATTERSON. (No abstract furnished.)

A radiation colorimeter.—E. J. WORKMAN. (No abstract furnished.)

The ionic activities in aqueous solutions of barium salts.—R. W. GELBACH.

Published in the following papers: Gel-

bach, R. W. and Pearce. The free energy solutions of aqueous solutions of barium chloride. Journ. Phys. Chem. 29: 1023-1925. Gelbach, R. W. and Huppke, Walter. The activity coefficients and transference numbers of barium bromide. Journ. Amer. Chem. Soc. 48: 1504. 1926.

How does elemental sulphur increase the amount of nitrogen in legumes?—J. R. NELLER.

Published in full in "The influence of sulphur and gypsum upon the composition and yield of legumes." Wash. Agr. Exp. Sta. Bul. 190: 1-47. 1925.

A possible substitute for hydrogen sulphide in analysis. — ALICE G. PATTERSON. (No abstract furnished.)

Some condensation products of O-Aminophenol and dicarbolyllic acid.—ARTHUR LEVINE. (No abstract furnished.)

Apparatus for Boyle's law and temperature coefficient of gases.—R. O. HUTCHINSON.

The flexible tube connecting the closed arm with the open arm manometer as found in the common form of each of the above named pieces of apparatus was found unsatisfactory: (1) because it fouled the mercury and hence the tubes; and (2) because leaks were very common at the metal connections. The present apparatus was designed to remedy these defects and others.

In the Boyle's law apparatus the closed arm containing the dry air, and the open arm have a rigid glass connection instead of a flexible tube. The change in pressure is secured through a third tube leading to a reservoir of mercury about half-way up the tube. The pressure of the air in this reservoir is lowered by an aspirator and increased by a bicycle pump, giving a variation from one-third to four-thirds atmospheres.

In the air thermometer the capillary tube which serves as the open arm of the manometer is joined to the bulb of the air thermometer by a second piece of capillary tubing cut from the same piece and bent so as to lie alongside the first. The base of these two tubes is joined by means of a larger glass tube bent into the form of an inverted U to a rubber tube which leads to a cistern o fmercury which can be raised or lowered. Trapped air in the inverted U-tube prevents mercury from the rubber tube from getting into the capillary tubes which therefore remain clean and easily read. The volume of the enclosed air is kept constant by always bringing the mercury in the closed arm of the capillary back to a given mark. On account of the smallness of the capillary the volume of the unheated portion of the air is negligible.

The effect of homogenization on the viscosity and stability of evaporated milk.—A. H. RISHOI. (No abstract furnished.)

The balancing of equations representing oxidation and reduction in inorganic reactions.—G. F. CLUKEY. (No abstract furnished.)

The general equation of wave motion applied to the bending of beams.—BENJAMIN H. BROWN.

For beams $\frac{d^2y}{dt^2} = \frac{V^2(d^2y)}{(dx^2)}$, other terms practically dropping out. V for soilds = the square root of $\frac{E}{D}$, $\frac{d^2y}{dt^2} = \frac{F\ (\text{force})}{D\ (\text{density})}$. Here F is the stress at unit distance from the neutral axis in any cross-section of the beam.

In a symmetrical beam, for example, M is the bending moment sustained by the stresses acting across the section.

$$\text{Thus } M = 2\int_0^C F\,Bx^2\,dx = \frac{2}{3}FBC^3$$

where B is breadth and 2C is the depth of the beam and $F = \frac{3}{2}\cdot\frac{M}{BC^3}$: also moment of inertia of the same

$$\text{section} = 2\int_0^C B\,x^2\,dx = \frac{2}{3}BC^3 = I;$$

therefore $F = \frac{M}{I}$, and $\frac{d^2y}{dx^2} = \frac{F}{DV^2} = \frac{MD}{IDE}$, the equation in common use.

GENERAL SESSION

The Purnell Act for the more complete endowment of Agricultural Experiment Stations.—E. C. JOHNSON. (No abstract furnished.)

Hydro-electric Power in Montana.—W. M. WEIBLE.

The purpose of this paper is to set forth the water sheds, the streams carrying the water, the location of the present power plants, the best power sites for the future,

the minimum power and the maximum power that can be developed in the state by ordinary dams and storage facilities, the maximum power that can be generated by full storage facilities in the mountains and the future prospects and possibilities of manufacturing in the state and its location.

The best power sites are located on the Missouri River and its tributaries, and Clark's Fork, a branch of the Columbia River, and its tributaries.

The following table shows the location of the present power plants and their respective output:

Great Falls, near Great Falls	84,000 H. P.
Rainbow Falls, near Great Falls	54,000 H. P.
Holter Dam, near Helena	47,000 H. P.
Thompson Falls, Clark's Fork	40,000 H. P.
Hauser Dam, near Helena	24,000 H. P.
Mystic Lake, near Billings	14,000 H. P.
Madison River, No. 1	13,500 H. P.
Canyon Ferry Dam, near Helena	10,000 H. P.
Big Hole Dam, near Divide	4,000 H. P.
Black Eagle Dam, near Great Falls	4,000 H. P.
Madison River, No. 2	2,500 H. P.
Livingston Falls at Livingston	2,500 H. P.
Plant at Billings	1,500 H. P.
Plant at Lewiston	600 H. P.
Plant near Kalispell	500 H. P.
Plant on Kootenai River	700 H. P.

Some few small plants used only for local purposes are scattered over the state.

The following table will give some idea of the future possibilities with normal storage facilities, east of the divide:

Milk River	30,000 to 50,000 H. P.
Jefferson River	317,000 to 482,000 H. P.
Marias River	55,000 to 75,000 H. P.
Madison River	216,000 to 276,000 H. P.
Gallitan River	94,000 to 126,000 H. P.
Musselshell River	23,000 to 26,000 H. P.
Yellowstone River	143,000 to 2,170,000 H. P.
St. Marys River	30,000 to 150,000 H. P.

This shows that the power east of the divide ranges from 900,000 H. P. to 3,350,000 H. P.

The following table will show the future possibilities west of the divide.

North Fork, Flathead River	30,000 to 100,000 H. P.
Coram, Flathead River	10,000 to 20,000 H. P.
Polson at Outlet of Flathead Lake	205,000 to 500,000 H. P.
Lower Flathead River	82,000 to 150,000 H. P.
Thompson Falls, Clark's Fork	20,000 to 25,000 H. P.
Donlan, Clark's Fork	40,000 to 75,000 H. P.
Rock Island, Clark's Fork	60,000 to 100,000 H. P.
Cabinet, Clark's Fork	90,000 to 150,000 H. P.
Fish Creek	24,000 to 50,000 H. P.
Kootenai Falls	Upward of 20,000 H. P.
Leoni Falls	Upward of 11,000 H. P.

This table shows that west of the divide there is a potential power varying from 567,000 H. P. to 1,200,000 H. P.

A great deal more power can be generated by putting in storage dams, such as the Hebgen dam now on the upper Madison.

The information which I have been able to secure, came from the U. S. G. S. office, the State Engineer's office, the Montana Power Co. and visits to some of the plants and sites themselves.

Hydro-electric and Power Development.—GEORGE NIXON. (No abstract furnished.)

National Parks as Places for Scientific Study (Illustrated).—M. J. ELROD. (No abstract furnished.)

The Unity of Science (Address of the retiring president).—M. F. ANGELL. (No abstract furnished.)

EDITOR'S NOTE

With this issue of NORTHWEST SCIENCE the abstracts of the papers presented at the first, second and third annual meetings of the Northwest Scientific Association have been published. The attention of members is now called to the opportunity for publishing scientific articles in the December and later issues. While the amount of space available is not large members are urged to submit their manuscripts to the Publication Committee. Under our present financial conditions long articles can not be accepted, but papers of moderate length dealing with scientific subjects of special interest to northwest scientists are desired.—F. D. HEALD.

Abstracts of Papers

presented before the
NORTHWEST SCIENTIFIC ASSOCIATION
at the
THIRD ANNUAL MEETING
DAVENPORT HOTEL, SPOKANE, WASHINGTON
DEC. 28-29, 1926

EDUCATION SECTION

Training the research worker. — C. C. CRAWFORD.

There is a shortage of trained research workers today because few are being trained by other agencies than the colleges and universities, and because these institutions are attempting to train them by individual apprenticeship methods.

To supply the need for research workers it is recommended that we adopt the practice of giving prospective graduate students a course in "Methods of Research" in their senior year and follow it by special research training in the particular branch of study which is to be pursued for the graduate thesis.

We must adopt large scale production methods in training research workers, just as we have adopted large scale methods in producing automobiles. The reasons for this are two-fold: first, we can thereby turn out more research workers; second, that they will enjoy the advantage of **interchangeable parts.** It is very important that research workers learn enough about fundamental principles of scientific methods so that they can cooperate with workers in other fields than their own.

Many students who would make good research workers fail to enter the field because they do not find out what it is like. Others hear such discouraging reports from graduates who are suffering in their attempts to conduct thesis investigations without adequate preparation that they resolve never to undertake the task.

The program of training recommended in the paper included: (1) Collection and organization of a fund of teachable material regarding methods of research; (2) offering this course to seniors in their first semester; (3) offering specialized courses such as statistical methods, methods of osterical research, etc., during the second semester of the senior year; and (4) individual apprenticeship training during the time the student is working on his thesis problem as a graduate student.

The relative reliability and validity of the true-false and traditional forms of extermination.—C. W. STONE.

Since my report of last year we have enlarged the study to include classes in Education, Psychology, United States History as taught in high school, and high school Physics. The method of the investigation continues to be correlating scores from True-False and scores from Traditional examinations with various criteria.

Our main concern is still to determine the best criterion for comparing the forms of examination. In this connection, we have investigated five possible criteria for Education classes: namely, average of all college grades, average of Education grades, intelligence scores, Thorndike word knowledge scores, and Education grades for the term. Our method of criteria study is to compute a composite of the above five by the McCall method. Then correlate scores from each of the five with the composite and correlate also each of the five with each of the others. Results to date show the following correlations:

Composite of all five with the average of all college grades	.85
Composite of all five with the average of all Education grades	.87
Composite of all five with the Otis intelligence scores	.76
Composite of all five with Thorndike word knowledge scores	.69
With Education 6 term grades	.84

This criteria investigation is also being pushed in the history study.

Results of the comparative study of the True-False and Traditional forms to date indicate a slight advantage for the True-False.

Some results of applying scientific methods to educational problems.—EDGAR E. RANDOLPH.

Published in Jour. Rural Education, 1925.

Language needs of children of foreign parents as determined by the use of standardized tests. — E. M. BLEVINS. (No abstract furnished.)

The application of scientific methods in supervision problems.—S. GAISER. (No abstract furnished.)

An analysis of the interests of Normal School students.—ARTHUR KOLSTAD.

There are but relatively few occupations for which more than half of the women students express a definite liking; the occupations with the percentage who like them are: teacher—91; musician—87; interior decorator—71; social worker—67; artist—66; singer—64; designer—62; librarian—61; athletic director—59; magazine writer—54; milliner—52; window trimmer—51.

The working conditions preferred by the majority of the students questioned called for: a regular time for work; wide variety in work; a larger future success rather than smaller immediate success; meeting new conditions; work with rapid rather than slow movements; original rather than imitative work; less rather than more responsibility.

Some of the trends seemingly noticeable from a study of the students' likes and dislikes:

There seemed to be some differentiation between those who received a grade of "A" and those who received "D" in Practice Teaching. The "A" student has more likes than dislikes of the different kinds of people; the "D" has more dislikes than likes. The "A" student has more interests among amusements than the "D". The contrast in working conditions indicates: all of the "A" practice teachers like working with people—most of the "D" teachers prefer working with things; all of the "As" like planning—most of the "Ds" prefer carrying out plans; almost all of the "As" like work requiring enthusiasm—the majority of the "D" express a liking for work requiring calmness.

In the expression of likes and dislikes for occupations more of the students with low intelligence ratings chose "Bank Clerk" and "Bookkeeping". All of those getting "D" in practice teaching liked "bookkeeping" and disliked "college professor"; while of those making an "A" grade, one-fourth like "bookkeeping", three-fourths disliked it, two-thirds liked "college professor", one-third disliked the occupation.

A preliminary report on studies of superior students.—FRANKLIN O. SMITH. (No abstract furnished.)

A new method of measuring color sensitivity.—FRANKLIN O. SMITH. (No abstract furnished.)

BOTANY AND ZOOLOGY SECTION

Behavior of the chipmunk.—H. S. BRODE.

A cottage by the seaside which was closed during the winter was opened on July 1 and a fire was built in the grate. In a short time a chipmunk came down one side of the fireplace and ran across the room and through the door. The next morning while there was still a fire in the grate, the chipmunk came in at the door and running past several people who were sitting near the fire climbed up into the chimney. In a short time it appeared carrying a well-developed young chipmunk. It held it by the skin on the ventral side with its teeth. The head, limbs, and tail were closely pressed against the sides of the head and neck of the parent. The young one kept very still and the only movement visible was a slight motion of the tail. The parent chipmunk ran into an adjoining room, climbed upon a trunk and from there to an open window and sliding down the outside wall, ran into the brush.

The chipmunk returned again and again and brought out four young in the same manner. It then went up the chimney twice again, returning each time without young.

Two weeks later the chipmunk and the four young ones were seen playing about at a short distance from the cottage.

Family life of birds at Mica Bay.—NETTIE M. COOK.

The paper recorded the number of species and individuals seen and presented notes on the following:

Location of nests, including—robin, Louisiana tanager, red start, red-eyed vireo, black-headed grosbeak, house wren, Schufeldt's junco, willow thrush, chickadee, rufous, humming bird, towhee.

Some chance meetings with the following birds: ruby-crowned kinglet, western flycatcher, willow thrush, chickadees, Louisiana tanager, western evening grosbeak, Canadian ruffed grouse, willow goldfinch, golden eagles, Cassin's purple finches, various woodpeckers, creepers, and many warblers.

The following are sample paragraphs of the paper:

Night claims you, e'er you are aware, and taps are hardly needed to send you off to sleep, for drowsiness has long o'ertaken you in the outdoor air. Gone is the flare of the sunset. Gone the evening flight of birds, and the ringing echoes of the willow

thrush. The last shadowy remembrance of camp is the silvered waters of the bay and the lone sentinels of fir trees across the bay.

You turn in your sleep. Some sound has penetrated to your consciousness. A whispered note, and you are aware there is a movement outside. You listen. The sibilant note is repeated. A western flycatcher is calling to its mate. The sleepy whisper is returned. You can almost see these birds shifting sleepily from one foot to the other. A sudden shake of the head, a lifting of the feathers, a stretch of each wing, and they have begun the birds' reveille. Your flashlight shows your watch to be 2:30 a. m.

A louder note. You say it is a robin. But no, you were mistaken. It is the call of the veery. Song bursts forth into bubbling roundelays. The calls echo from wall to wall. You discover this orchestra hidden in the thicket up the draw. Now begins the extended program of bird mimics. The notes vibrate and resound. The chords blend one into the other like the sounding pipes in a great organ.

Further studies in the photosynthesis of some red and brown algae.—F. W. GAIL.

Published in full in Publications Puget Sound Biol. Sta. 3: 177-193. 1925.

Preliminary survey of hay fever plants west of the Cascades.—T. A. BONSER.

In general, the region west of the Cascades can be divided into two distinct botanical regions, according to the characteristic plants of each. The one area extends from Vancouver, B. C., to Eugene, Oregon, or thereabouts; the other from about Roseburg, Oregon, to Northern California.

In the northern region, the velvet grass *(Holcus lanatus)* is by far the most abundant species. In the southern region, the various species of brome-grasses, squirrel tail, perennial rye-grasses, and the narrow-leaved plantain greatly surpass the velvet grass in abundance.

The northern region was again subdivided into eight subregions, while the southern was considered as one. A separate list was made of the possible hay fever plants in each subregion. The relative abundance of each species was indicated by prefixing from one X to 6Xs, as only the most abundant species are likely to be the most important factors in producing hay fever.

The number of plants listed in each subregion varied from twenty- to fifty-six.

The greatest number were listed from Portland and vicinity and from Seattle and vicinity, as these are the centers of the greatest population. The advantage of listing the hay fever plants in the subregion becomes evident, when we consider the fact that this will furnish a more convenient list to work with for the local doctors who must administer the treatment to the individual patients.

A case of linkage in wheat. — E. F. GAINES.

Velvet node, a character recently discovered in wheat, is closely linked with the bearded character, but two crossovers occurring in 393 F_2 plants. The velvet node is a hairy growth over the nodal joints and immediately above on the leaf sheaths, and occurs on the F_1 plant as a dominant. The bearded character reacts as a recessive.

Precipitation cycles in Northern Idaho and Northwestern Montana.—H. T. GISBORNE.

A comparison of fluctuations of rainfall and forest fires in the northern Rocky Mountains has shown the presence of fluctuations of rainfall of such amplitude and periodicity as to indicate that they are cyclic. Rainfall records for the calendar months, April to September, 1881 to 1924, inclusive, for the three stations, Spokane, Walla Walla, and Missoula, are the basic data. The average for these three stations for each of the stated months was computed, plotted, and the resultant curve smoothed by the use of an 8-year moving mean for individual months, and a 4-year moving mean for groups of three consecutive months, April, May, and June, termed spring, and July, August, and September, termed summer.

The smoothed curve for April shows two distinct crests and two distinct troughs, with a periodicity of about 20 to 22 years. The amplitude has varied from a maximum average for 8 successive Aprils of 1.67 inches to a minimum average of 0.86 inches, which is equivalent to a variation from 34% above to 34% below the present normal for April.

May shows a periodicity estimated at 45 to 50 years, only one complete crest being shown. The maximum average rainfall for 8 successive Mays amounts to 2.19 inches, the minimum 1.06 inches, or a variation from 36% above to 34% below normal.

June rainfall appears to have fluctuated in accordance with two cycles, the major being about 60 to 70 years in duration, the minor about 22 years. The maximum

average rainfall for 8 successive Junes amounted to 2.34 inches, the minimum 0.89 inches, or the difference between 53% above and 42% below the present normal.

April, May, and June, as a group called spring, show a periodicity of about 8 years. The average precipitation for 4 successive springs has been as high as 5.50 inches, and as low as 2.54 inches.

July and August show little, if any, cyclic fluctuation. September, however, shows a distinct periodicity of about 16 years, and a range from as high as 1.43 inches average for 8 successive Septembers, to as low as 0.64 inches average.

July, August, and September, as a group called summer, show an irregular periodicity with a maximum average of 3.10 inches for 4 successive summers, and a minimum average of 1.43 inches.

Checks made by using the records of other stations in this region covering a shorter period of time show that the average for Spokane, Walla Walla, and Missoula, is very indicative for the region as a whole. When the method was used on the records of Havre, Helena, and Yellowstone Park, also Seattle, Olympia, and North Head, pronounced and very regular fluctuations were found.

It is believed that the results of many of our research projects, as well as forest fires, are influenced by these fluctuations. If they continue in the future as during the past 44 years, they may be found to be truly cyclic. No attempt is made by the present study to explain the causes of these pronounced and regular fluctuations.

Notes on the behavior of Lewisia.—J. E. KIRKWOOD.

The Bitter Root *(Lewisia rediviva)* is a low fleshy perennial herb, the roots of which are used by western Indians as a food. They contain a considerable amount of carbohydrate material. The bitter constituent resides mainly in the thin periderm and from analysis seems to be a glucoside. Only slight traces of tannin appear in the extracts. Starch is the principal nutritive substance, with small amounts of protein.

Unmodified cellulose forms a considerable part of the cell walls with some slight lignification in the vascular tissue. Application of reagents shows a thin rind of suberized cells. Within this, an amount of more than one-third of the whole diameter is the starch bearing tissue. Determinations were made of the water, solid, ash and organic content from fresh tissue. The average solid of the season amounts to 27.76% and the moisture conversely, 72.33, although the amounts vary with the progress of the season. The average of the ash for the same tissue taken at the same time was 3.7% and conversely the organic content, 96.3%. Changes in the composition on the tissue is correlated with special phases of vegetative and reproductive activity of the plant. An unusual feature appears in the retraction of the leaves which begins with the emerging of the first flower. This contraction of the leaves is associated with the contraction of spirally thickened vascular elements.

Influence of certain crops upon the yield of succeeding crops.—E. G. SCHAFER. (No abstract furnished.)

Chromosomes of the cereal small grains.—E. F. GAINES.

All species and varieties of wheat, oats, barley and rye have the gametic number of 7 chromosomes or multiples of 7 in the material examined. In wheat, Einkorn has 7, Emmer, Polish, Durum and Poulard have 14, while Vulgare, Club and Spelt have 21. The cultivated varieties of oats all have 21, but certain wild species have either 7 or 14. In barley the cultivated forms have 7, but certain wild species have 7 while others have 14.

In species-crosses of wheat differing in chromosome number, the author has never been able to develop a variety with perfect fertility except those having 7, 14 or 21 chromosomes.

Many characters in the cultivated varieties of wheat and oats are inherited as triple allelomorphs. Since these species have 21 chromosomes, it is suggested that they may have developed by a doubling of the chromosomes from the wild forms. In the cultivated barleys which have but 7 chromosomes, most of the characters are inherited as simple Mendelian units.

A sympetalous buttercup.—E. B. HARRIS.

The paper under the above caption was a report on a small patch of *Ranunculus glaberrimus* which exhibited the unusual feature of the petals being joined into a perfect cup. An attempt was made to self-fertilize the plants without success.

Membership List of the Northwest Scientific Association Revised to September 15, 1927

MAY 1ST, 1927

Adams, William E. (Social Science), Box 704, Spokane, Washington

Anderson, George H. (Physician), 442 Paulsen Bldg., Spokane, Washington

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Angell, M. F. (Physics), University of Idaho, Moscow, Idaho

Armstrong, L. K. (Mining Engineer), 720 Peyton Bldg., Spokane, Washington

Armstrong, Oria .V., Route 1, Mound, Minnesota

Aspray, Joseph (Physician), Old National Bank Bldg., Spokane, Washington

Avery, A. G. (Attorney), Peyton Bldg., Spokane, Washington

Baldwin, Robert D. (Psychology and Education), Pres. Normal School, Stevens Point, Wisconsin

Barbee, O. E. (Agronomy), State College of Washington, Pullman, Washington

Barnes, Virgil E. (Geology), State College of Washington, Pullman, Washington

Barss, H. P. (Botany, Plant Pathology), Oregon Agr. College, Corvallis, Oregon

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Barton, J. W. (Psychology), University of Idaho, Moscow, Idaho

Batchelor, Harold W. (Bacteriology), University of Wisconsin, Madison, Wisconsin

Bateman, W. G. (Chemistry), University of Montana, Missoula, Montana

Bender, Jacob R. (Mathematics, Physics), University of Idaho, Moscow, Idaho

Benn, William J., S. J. (Psychology), Mt. St. Michael's, Hillyard, Washington

Bennett, W. G. (Geology), Pullman, Washington

Berg, Gunnar H. (General Science), State Normal School, Bellingham, Washington

Berry, E. Clifford (Chemistry, Physics), Cheney, Washington

Betts, Robert M. (Mining Engineer), Cornucopia, Oregon

Bever, James (Social Science), State Normal School, Bellingham, Washington

Bitney, Raymond H. (Forestry, Ecology), Klamath Agency, Oregon

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Bonser, Thomas A. (Botany, Geology), E. 1427 Providence Avenue, or Spokane Museum, Spokane, Washington

Boyle, Lytton W. (Plant Pathology), Agricultural College, Fargo, North Dakota

Bradt, Wilbur E. (Chemistry), University of Cincinnati, Cincinnati, Ohio

Brannon, M. A. (Botany), Chancellor University of Montana, Helena, Montana

Bretz, J. Harlen (Geology), University of Chicago, Chicago, Illinois

Brewster, C. M. (Chemistry), State College of Washington, Pullman, Washington

Brode, Howard S. (Zoology, Botany), 433 E. Alder, Walla Walla, Washington

Brown, Benjamin H. (Physics), Whitman College, Walla Walla, Washington

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Bryan, Kirk (Geology), U. S. Geol. Survey, Washington, D. C.

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Cady, Louis C. (Chemistry), University of Idaho, Moscow, Idaho

Carder, Dean S. (Geology), Palouse, Washington

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Cayne, Marie (Geography, Agriculture, Birds), S. 210 Adams St., Spokane, Washington

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Childs, Leroy (Plant Path., Ent., Pomology), Hood River, Oregon

Clapp, Charles H. (Geology, Chemistry), Pres. State University, Missoula, Montana

Clark, Herman (Physical and Organic Chem.), Willamette University, Salem, Oregon

Clark, Lois (Botany), University of Idaho, Moscow, Idaho

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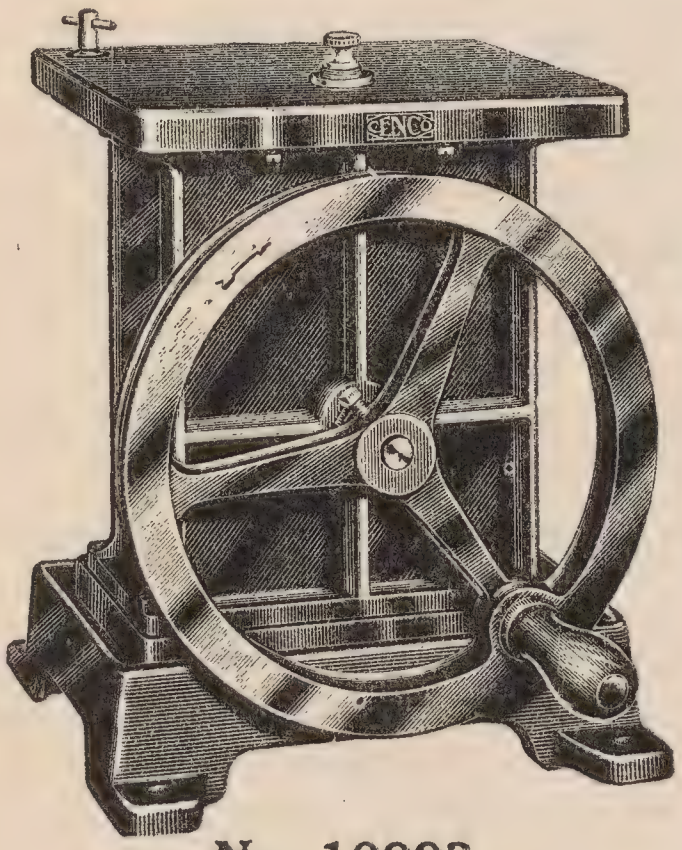

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FOREWORD

With this issue of Northwest Science the Publication Committee completes the work for which it was appointed. The Business Meeting of Northwest Scientific Association on the morning of December 29 will no doubt determine what shall be the future policy with regard to publications. It is interesting that the various calls for papers have brought forth a number of excellent articles. Notably a botany article of outstanding interest and merit. It seems that there is easily possible an issue on regional botany, should that appear desirable. Members have mentioned an interest in a possible Forestry number and one devoted to the Social Sciences. With the usual abstracts of the papers presented at the coming December meeting and other papers on various subjects now available it seems that from the side of papers to be printed no difficulty need be experienced in carrying on for another year.

From the side of finances the sky is not so clear. If members will recall that this is a cooperative enterprise and give aid by securing subscribers and advertising, the financial side need present no formidable difficulties. One thousand readers for Northwest Science would make the work of the Business Management comparatively light and permit desirable improvements.

The program printed in this issue tells its own story. With each succeeding year it becomes more evident that Northwest Scientific Association is accomplishing its aim of encouragement of research, facilitating the publication of work of members and the diffusion of scientific knowledge. Outstanding as one of the finest results of our four years of growth is the fine fellowship among the scientific people of the Northwest who were strangers to each other when we began.

Suggestions to the Social Science Section of the Northwest Scientific Association

By ENOCH A. BRYAN

Research Professor of Economics, Washington State College.

The science which deals with human associations is well called social science, or sociology.

By usage **Sociology** as a branch of Research and Education has come to be confined pretty largely to the study of man in his primitive state and his primitive institutions or on the other hand to the problems arising from a complex civilization, such as labor, wages, poverty and pauperism, the relation of sanitation to human welfare, the housing problem, the unemployment problem, old age, accident and unemployment insurance, delinquency of youth, insanity, and a host of other problems connected with the unfortunate or incapable. The term sociological or social problems would be far more applicable than the more comprehensive term Sociology.

Among the problems of social science one of the most important is that relating t o the means of subsistence, namely, the necessities, comforts and lururies of man. The material things which minister to the wants and needs of man we call wealth, and the science which deals with this we call **Economics** or the Science of Wealth. Wealth is the most fundamental necessity for human welfare and hence Economics is perhaps the most fundamental of the social sciences.

So far as we know, even under the most primitive conditions, men are organized politically. That is to say there are rules, customs, understandings governing the duties, responsibilities and relationships of the individual members of the group, and there are those of the group who, either by the choice of the group, or its consent, or by usurpation, guide or direct or control the members of the group in their mutual relations. Such organization, however primitive, is called "Government" and the Science of Government or the Science of **Politics** is a very fundamental and primary branch of social science.

The science which, by its research, seeks out and sorts out and classifies the facts relative to all human relationships and makes a record of all or any part of these events, or seeks and sets forth the philosophy of the activities of mankind we call **History** (Human history). It offers the basic methods of procedure in all the other social sciences without which there could be no scientific method in the study of social science. It furnishes the basis of study, as the rock does to the geologist, as the chemical compound does to the chemist, as the plant does to the Botanist. Therefore, **History** must be included as one of the Social Sciences.

The list is not complete and even in these there will arise subdivisions. But for our present purpose we might give the grand-divisions of Social Science as follows:

1. Sociology (in its modern usage).
2. Economics.
3. Politics or the Science of Government.
4. History.

In due course of time it may happen that these subdivisions shall increase in number and in interest so as to render advisable separate organization for the study of any one of them. When that is best let it so be. But it should be remembered that there are close relationships as well as differences, and that human society is a whole—is a web—not a patchwork, and that there is great strength in unity and in numbers and it would be wise to postpone the day of separation as long as possible.

Meanwhile the general pattern to be followed has been well set forth by the parent organization—The Northwest Scientific Association.

The "big idea" is research — individual research—cooperative research (which is also individual)—fairly frequent meetings of the section, the presentation in written form of the results of research—even the scraps and incomplete portion of larger undertakings, the filing and preserving and listing of all papers, with the names of their contributors. There should be provision for criticism, for attack and defense. From time to time competent persons should be invited to present papers on methods and the technique of Research, on methods of weighing evidence, of separating the false from the true,

There should also be the organization of those of kindred interests for team-work on specific problems. A subject of investigation having been agreed upon, an analysis of the subject having been accepted there should be an assignment of parts to the cooperators and definite time agreed upon for the assembling and coordinating of the several parts.

For example, there is before the people of the State of Washington just now a most important economic question on Taxation. Hitherto, in accordance with the provision in our Constitution, taxes are levied on all property in proportion to its cash value. This gives us primarily a property tax system. A constitutional amendment has been proposed by the late legislature providing that all property be classified and that different rates of taxation be laid upon different classes of property. For example, one rate upon timber in proportion to its value, another upon farm land, another upon promissory notes, bonds, stocks and other securities, another upon mines, another upon stocks of merchandise, another upon franchises, etc., etc., there being no end to the possible classification.

Of course there is the question as to whether the wise citizen should vote for or against this amendment. But that would not be a good question for this section to argue, for its function is not primarily argument, but to seek out and set in order fundamental facts and frinciples. This section might even accept the dictum of economists as to the fundamental principles which should govern taxation, and attack the problem of the application of those principles to existing conditions.

There are many basic considerations which ought to be sought out and set in order which would be of great use in the determination of a right course of political action.

For example, one group of this section might undertake to ascertain in any given political division (or many divisions) say Spokane City or Spokane County, how many adults over 21 years of age pay no direct taxes whatsoever. This would involve a list of all taxpayers with the total of their taxes (exclusive of improvement assessments). This, while tedious, would be fairly easy to get and it would also reveal the size and importance for revenue purposes of the small taxpayer, the middle-sized taxpayer and the large tax payer. Another division of the group might undertake to ascertain the total number of citizens over 21 and by subtraction of the number of taxpayers, the number of those who pay no taxes directly. This list would not be so easy. Polk's directory (in the city), poll lists, and the like would be the sources, and the results would in part be an estimate at any time except at the U. S. census period. The result thus far would reveal, however, the two classes, the taxpayer and the non-taxpayer. It might also reveal the classification of the non-taxpaying group. A comparison now of the burden of taxation resting on public utilities which can be and are passed on to the taxpaying and non-taxpaying groups alike, that is, to the consumer, and in proportion to their consumption of the service or commodity, would be revealed. It would thus appear that the non-taxpaying group (largely laborers and salary earners) do, as a matter of fact, out of their income pay a large portion of the taxes. It would perhaps not be possible to ascertain beyond a rough estimate what other classes there are which are able to pass on the tax burden to the consumer pay.

It might be possible likewise to make a valuable study of the burden of taxation which rests on other classes such as the owners of timber, the owners of farm land and the like which cannot be passed on. A study of the antiquated assessment schedules with the revenues yielded by different classes of property would be a useful study. A comparison of the property tax system with an income tax system, a severance tax, or a corporation tax would likewise be illustrations of useful fields of scientific research.

I have used the illustration of a study of taxation (in which educational people have a vital interest) as one type of economic study which might be pursued with profit.

I recall an extended study made by a club in the Plymouth Church, Indianapolis, years ago which will illustrate one type of sociological study. The Rev. Mr. McCulloch was pastor of the church and with large vision he saw that many things aside from church dogma and exhortation to love and good works were desirable in a working church. I wish I had for your examination the result of some years of careful research by that group as embodied in a little pamphlet with graphic illustrations, which set forth in part the fruits of the labor of many social science students—members of that club. It was entitled "The Tribe of Ishmael." It was a study of the hereditary element in crime and pauperism, primarily in Indianapolis but hav-

ing throughout the state of Indiana many ramifications. The pamphlet was a mere indication of the careful and voluminous investigation of which it was one illustration. As the studies grew there appeared on the canvas a distinctly criminal class to which belonged a large percentage of the criminals through years of time as revealed by police and superior court and criminal records. The records of poor relief and poorhouses revealed the fact that in the same class were many paupers or semipaupers. The divorce courts also made their contribution to the class. Names gave a key to the class and then appeared the strange fact that kinship of blood and marriage stood out as an unescapable fact running through the web of crime and pauperism and incapacity. Flower girls standing at the doors of theaters, with eyelids scorched with acid to make them objects of pity and charity were numerous. Beggars were within the group. Fakirs were there. Then a discovery was made, of dramatic interest, viz., that an old fellow by the name of Ishmael, with a numerous family of unhealthy, poverty stricken, illiterate children had, at an early day, migrated from the south and settled in Indianapolis. The family came through Kentucky and the Tennessee Mountains and perhaps originally from Georgia (we instantly think of the Oglethorpe colonization of exprisoners) and belonged to that class which southerners called "poor white trash." The family was prolific. They bred like Belgian hares — and with not much more ceremony. They had intermarried much. Their history was to be read in police courts, criminal courts, divorce courts, commitments of imbeciles, poor relief, poorhouses and the like. In the main the crimes were petty and the poverty great. But they were not without family membership of considerable wealth and some education and connection with crimes of great magnitude and costliness. It was clear that if this cancer in the body politic could have been cut out in an early day the state would have been relieved of great loss and the social health would have been much better. I have recited this story because it illustrates a type of work which might be overlooked. For the most part, however, the work is likely to be individual, and to be submitted in individual papers.

It is a great satisfaction to the scholar to be able to present the results of his work to kindred souls and to be benefited by their criticism and suggestions. Many pieces of work would deserve to be and should be printed. All should be listed, filed and kept.

Perhaps it would be wise if the membership should be requested to announce one of the four fields of Social Science in which he desires to work. Perhaps, also, the minimum requirement should be at least one piece of work each year. The members should be encouraged to make scientific contributions from time to time in well-known periodical publications. Northwest Science, the official publication of the parent body will doubtless be able to use an epitome of some papers and to announce the titles and authors of all.

I do not know if there is an executive committee of the section. If so, it should be charged not only with the duty of seeking out and bringing into the fold all interested and competent persons, but also in suggesting topics of study and cooperating groups. In my own field of Economics there are many interesting topics. Hydroelectric development is as yet very recent —dating from about 1886-7—say 40 years. Yet it has passed through say four stages already. The first primitive period of small companies or individuals, their aggregation into larger locality groups, the period of receiverships and the period of still larger aggregations with interchangeable power and centralized content. Railways present a like problem. The Rise and Fall of the Interurban is a fine field for investigation. Automotors and the Highways open a new field. The study of population problems is forever with us. The several stages of the mining industry are as interesting and dramatic as romance can be.

Charles Doolittle Walcott, Citizen, Administrator and Scientist

By N. W. DURHAM

The life work of Charles D. Walcott is an impressive reminder of an eternal truth—that science is handmaid of civilization, benefactor of mankind and inspiration to religious reflection and high emotion.

No man has done more in our generation than Dr. Walcott, to interpret the enduring revelations that God has written deep in the rocks of his continents.

The president of a college of the Inland Empire said recently, addressing the student assembly of another institution of higher learning, that the American as a type grasps a new idea as a trout snatches a fly, but that he is short on meditative and reflective thinking. If that estimate is confined to philosophy, metaphysics and literature, it may be a nearly accurate measure of this nation. But distinctly and impressively it is not true in the realm of science, for never has there been a period in the world's history when so great a host of truly devout men and women consecrated their lives to incessant study of the laws of the sublime spirit of the Universe that we term God.

It is fitting that the West should honor Dr. Walcott's memory, for his studies included the chief known bodies of Cambrian and pre-Cambrian rocks in Montana, Idaho, Wyoming, Nevada, California, Arizona and South Dakota. His thoroughness is indicated by his statement in 1918, that "In 1873 I said to Professor Louis Agassiz that if opportunity offered I would undertake as one bit of future research work to determine the structure of the trilobite. This promise has kept me at the problem for 45 years."

For 48 years he was continuously with the U. S. geological survey and the Smithsonian Institution.

Yet with all his unsurpassed contribution to the knowledge of the world's institutions of higher learning, Dr. Walcott was not a collegian. Like Franklin and Edison, he was a great scientist who never studied in college halls. For ten years only, and that in early life, was he in school. A child of 8, he entered the public schools of Utica. Ten years later he left Utica academy to face the world, the great world of endeavor and service. And like millions of other ambitious and willing youths, he was not above putting his mind and hand to the first honest work that came his way. For two years he was a clerk in a hardware store. For three years, in his deep love for science, he labored at farm work for his board, that he might follow his boyish bent for closer study of the fossils in the adjacent rocks, for his interest in prehistoric life began when he was 13. "As a boy of 17," he said in after years, "I planned to study those older fossiliferous rocks of the North American continent which the great English geologist, Adam Sedgwick, had called the Cambrian system from his finding them in the Cambrian district of Wales."

How nearly he came to attainment of his boyish ambition we can better understand from a recent statement by a colleague, that 70 per cent. of the world's knowledge of Cambrian paleontology was contributed by him.

For a while he halted between two inviting careers—the business world and the world of science, and science became his mistress. For several years he pursued his field studies and the collection of fossils while he worked at farm labor for his board. And his amazing progress is indicated by the amazing fact that this youth of 23 who never had entered college halls, sold in 1873 his personal collection of limestone fossils to the Museum of Comparative Zoology of Harvard college.

But his real life work, for which all previous labor had been the preparation began in 1879 when he was appointed field assistant in the United States Geological Survey, then under the direction of Clarence King and was assigned to the study of the great geological section extending from the high plateaus of southern Utah to the bottom of the Grand Canyon of the Colorado.

In these field studies he ranged over a great part of the North American continent. One year we find him in a Nevada

*Delivered March 31, 1927 before the students of Spokane University at the Walcott Memorial Meeting.

mining camp. He studied the Cambrian formation of the Appalachian range all the way from Alabama to Quebec, and his field work carried him from the Mexican border into British Columbia and Alberta.

Between 1902 and 1907 he directed the organization and the conduct of the United States Reclamation Service.

As executive secretary of the Smithsonian Institution, his energy was unstintingly given to the many-sided tasks of carrying out the purpose of its founder, for the "increase and diffusion of knowledge among men." He was instrumental in the organization of the National Advisory committee for Aeronautics and became its chairman, thus continuing the Smithsonian's support of the then crude science of aviation which had been rescued from ridicule by his predecessor Langley. The memorable expedition of Theodore Roosevelt into Africa in 1909 and 1910 was made under his direction. During the World war he was chairman of the military section of the National Research Council, and in 1917 he was made president of the National Academy of Sciences.

The occasion of Dr. Walcott's visit to Cambridge, England, in 1909 was seized by his admirers to confer upon him the degree of Dortor of Science. Other degrees had previously been awarded him by Chicago University, Johns Hopkins, Hamilton, Pennsylvania, Yale, St. Andrews in Scotland, and Pittsburg, while those by Royal Fredericks at Christiania, and Harvard were received later, the latter just 40 years after the Harvard purchase of his collection of fossils.

As we have seen, Dr. Walcott was not college-trained. Nevertheless he drew freely from the fountains of knowledge flowing out from the colleges of many countries. His guiding principle was to drain those fountains and then go to Nature for still deeper wells of learning.

Dr. Norman F. Coleman, president of Reed College at Portland, addressing the students and faculty members at Washington State College this week, censured the student or scientist who attempts to study alone. "He can be likened," said Dr. Coleman, "to a lone man attempting to search for some lost person on a mountain. He is helpless at best, and may even become lost himself."

That never was the spirit or the attitude of Dr. Walcott, as boy, as youth, as recognized and honored peer in the scientific world. From the beginning he sought association with the scientists of his day—with Agassiz, who counseled him to go to Harvard, but whose counsel was thwarted by circumstances; with the state geologist of New York, and with doubly gifted Clarence King, who blended as no other scientist of our country has been able to blend, accurate scientific knowledge and the gift of expression in rare literary charm, and whose appointment as director of the United States Geological Survey was speedily followed by an order assigning young Walcott to a study of the great geological section that is comprised in the drainage system of the Colorado river.

It is of fascinating interest to speculate upon the initial forces that subsequently made the United States a leader in research science, and which drew with alluring appeal to the pursuit of science this master scientist when he was a boy of 13, and bound him in silken bonds of affection and service for nearly two-thirds of a century.

In the inception of that influence three names of great Americans will stand out with gathering illumination through the centuries — Franklin, Washington, Jefferson: Franklin, by his amazing discoveries, Washington by his abiding counsel, Jefferson by the Lewis and Clark expedition for Lewis and Clark were the first great field scientists of their period. Within the three years from 1804 to 1806 that brought them from the Potomac to the Pacific, they gathered a stupendous store of knowledge of the flora and the fauna, the geology and geography, and ethnology of the native races of a vast wilderness that they were first of the white race to traverse.

Their heroic and fascinating achievements must have been a potent appeal to Walcott, the boy and youth, and to a host of others who early took science for their bride and never were daunted into separation by her arduous exactions and her scanty financial rewards.

Dr. Walcott's crowning service was his leadership of 20 years in the Smithsonian Institution.

Eighty years ago the Smithsonian Institution had its origin in the magnificent conception of James Smithson, an English scientist, who bequathed his personal fortune of $500,000, a great sum at that time, "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men."

A great part of its growth was under

the executive direction of Dr. Walcott, and it now comprises:

The United States National Museum.

The Bureau of American Ethnology, devoted to scientific study of the native races of this continent.

An Astro-physical Observatory.

A National Zoological Park.

The National Gallery of Art.

The Freer Gallery of Art.

An International Exchange.

In miniature, then, our Public Museum in Spokane is a regional Smithsonian Institution, with its collections of natural history, its exhibits of the handiwork of the Native races, and its feeble beginning as an art gallery.

And there exists, too, a close analogy between the slow response of public interest and support that often discouraged the noble men who had the Smithsonian so deeply at heart, and the struggles and poverty of our own museum.

Public apathy, congressional misunderstanding, conflicting views about the relative importance of Natural History and Art, it was Dr. Walcott's task to overcome and adjust. If his character had not been an extraordinary blending of scholar and practical business man, of inspirational leader and persuasive counselor to presidents and members of congress, of sympathetic adviser and executive talent; and had he not, in addition to all that, been blessed with extraordinary capacity for hard work, mental and physical, this and similar memorial gatherings would not now be assembled to honor his memory and give thanks for his surpassing service to science and industry, to knowledge and culture, and the greater glory of this nation and the name American.

To Dr. Walcott, from his boyhood to his grave, Nature spoke "a various language." The trees spoke to him, and his constructive answer is the national forests. The running brooks told him of their longing to water the thirsty desert, and his influence will live for all time in national reclamation. And in the rocks of his native state and our western mountains he read the story of God's creation and interpreted it for his countrymen and all the world beside, for the greater glory of his Creator and his country.

An Investigation of Lightning Storms in the Northern Rocky Mt. Region

By H. T. GISBORNE, Associate Silviculturist,
Northern Rocky Mt. Forest Experiment Station.

Lightning is an extremely important natural phenomenon in the northern Rocky Mountain region. It is important not only to all owners of forest land, the loss due to lightning-caused forest fires in Idaho and Montana amounting to over $3,500,000 in 1926, but also to all owners of buildings and livestock, to insurance companies, and to telegraph, telephone, and power companies. Few people appreciate the immensity of the annual loss due to lightning, while even fewer realize the lack of research devoted to this problem.

Early in 1922, when the U. S. Forest Service initiated intensive forest-fire research in Montana and Idaho, a working plan was made, as one of the projects, to guide a study of lightning storms in relation to forest fires. This plan, which is still being followed, with improvements resulting from experience, was sufficiently broad to permit the collection of data on storms as well as lightning strikes, and the information collected is already proving of further value by aiding the U. S. Weather Bureau in improving the accuracy of its forecasts for this region. Obviously, improvements in the weather forecasts are of value to almost all industries and to nearly all individuals.

This investigation, by the Northern Rocky Mt. Forest Experiment Station, is using the network of over 170 forest-fire lookouts, stationed on the mountain tops in the region, as a means of observing the storms and reporting their characteristics. These lookouts are so close together, seldom over 30 miles apart in the mountains, that it is almost impossible for a lightning storm to occur during July and August without being seen or heard and, therefore, reported. As the principal period of danger from lightning corresponds to the period when the lookout stations are oc-

cupied, this method is providing excellent results, which are changing some of our conceptions rather radically.

We already know that the mountain areas experience at least three times as many lightning-storm days as had been indicated by the best records obtained previous to 1922. The expression is sometimes heard, nevertheless, that lightning is of uncommon occurrence in this region. So long as the 170 lookouts continue to submit from 2,000 to 3,000 storm reports each season, as they have done during the past few years, it would seem that lightning is decidedly common. The analyses of these reports have shown that during the 62-day period included by July and August, there was at least one storm in the region on 49 days in 1924, on 57 days in 1925, and on 52 days in 1926.

Consequently, if lightning storms were forecast for the region every day during July and August, and if the occurrence of one storm verified the forecast, such predictions would be from 80% to 92% correct. Naturally, however, one storm does not imply danger for the entire region; first, because single storms are usually small in area and do not travel more than 60 to 100 miles; and second, because the degree of danger inherent in a lightning storm varies from nothing to 100%. Many storms have been reported in which all the lightning was confined to the clouds. In 1926, one storm over part of the Clearwater Forest in Idaho delivered only one flash of lightning. That one strike, however, started a forest fire which covered over 15,000 acres of land before it was controlled. This storm was certainly 100% dangerous. With such a variation known to occur, it is obvious that useable forecasts of lightning-storm occurrence, and preparations to cope with the danger, must be specific both as to area covered and degree of probable danger.

The records collected to date in the present study indicate that lightning storms occur with about equal frequency in eastern Montana and in northern Idaho. The common degree of danger, however, is decidedly different in these two regions, only one storm out of 10 usually starts a forest fire in the former region, whereas about half the northern Idaho storms have been fire starters. All of the controls, and their relative importance in producing this difference have not yet been determined. Some of them stand out clearly in the records.

One of the primary controls of degree of fire danger has been found to be the amount of rain delivered by the lightning storm. The records show that the average duration of rainfall is slightly less for the average fire-starting storm, than for the non-dangerous one. This seems perfectly natural, but the reports tend to contradict this, as a general conclusion, by showing that during some seasons, at least, there has been more rainfall with the dangerous storms in Idaho than with the safe storms in eastern Montana. Hence, other conditions must be recognized at times as equalling the importance of the rainfall.

Timber type and the natural inflammability of the forest fuels is believed to have an important effect on the number of lightning fires, but no specific data are available as yet to indicate whether this belief is right or wrong. The lightning storm reports themselves show that one very important factor is the percentage of lightning striking the ground. The typical nonfire-starting storm usually has over 60% of its lightning striking the ground. The total number of flashes is, of course, a very important factor, but as yet it has not been feasible to collect data on this phase of the problem. As the research laboratories of the American Telephone and Telegraph Company have stated their interest in the total number of strikes, the working plan has been modified to include some special observations on this condition beginning in 1928.

There are several other features of lightning storms which are being observed by the lookouts and reported on the specially prepared forms. Some of these include, the hours of occurrence, the areas covered, the paths followed, and the time interval between first sighting each storm and the discovery of each resultant fire. As the observers become more adept in making accurate observations, and as the volume of reports increases, a supply of data is being obtained which will permit the use of statistical methods of analysis capable of insuring very dedendable conclusions. In co-operation with Dean M. F. Angell, of the University of Idaho, an experiment has also been started in measuring the atmospheric potential gradient to determine whether or not this condition is an index or component of the degree of lightning danger. Although we may never be able to stop lightning from striking, we should be able to learn much more about its occurrence and characteristics and thereby modify our actions to reduce the loss very appreciably.

High School, the Threshold of Science

By FREDERIC G. KENNEDY

Principal, North Central High School,

Spokane, Washington.

If we are to believe the utterings of the press and the pronouncements from pulpit and forum of today we are faced with a certain disintegration of society—at least from its more or less accepted concept of a generation ago. We are called upon to observe and be concerned over the breaking up of the home, the revolt of youth, the popular disregard for sacred vows, money-madness, pleasure-madness, disregard for the law and indifference to duties of citizenship.

Whatever may be your opinion with regard to these assertions, whether or not you believe in the existence of any or all of these social trends, I feel sure that you return from their consideration, to a contemplation of the eternal verities of science with a deep sense of relief. To me it is comparable with that sense of security that comes to the captain of a drifting vessel when he feels his anchor take hold of something solid below, and knows that the good ship will ride still another storm safe from the pounding surf.

High school pupils have reached a maturity of mind fitting them to receive instruction in the fundamentals of science. Thoroughgoing study in the whole field is of two-fold value—factual content, and, what is perhaps more important, the scientific viewpoint. We cannot make scientists of high school boys and girls but we can fortify them against quackery; we can give them a wholesome suspiciousness of the miraculous. Merely to kill forever the childish hope of perpetual motion is to have accomplished much.

I know of nothing more tragic than the onward march of thousands of young people out into the maze of a complex society, unequipped with any scientific knowledge or training to help determine the true from the false.

If we can teach them something of the scientific approach, selecting and collecting the pertinent facts—all of them,—open mindedness, that is, the refusal to form a conclusion with too few data at hand, are we not preparing them to deal with social problems as well as with material research?

The general prevalency of ignorance of simple scientific truths is appalling. It makes possible the promotion of vast numbers of quack schemes, and the collection from the general public of millions in money annually; nor is this money taken largely from those who can afford to lose it. Probably the most fertile field is that of human physical ills. A young man in this city with nothing more than a grade school education left a job as wireman's assistant and took a three months' "doctor's" course in a distant city. He was then "fitted" to return and start practicing in our midst! No more wiring for him. Now after three years he is more than well-to-do. Who were his patients? A clever Los Angeles promoter devises a to the house lighting circuit "magnetizes the iron in the blood" thereby "curing" all ills. So great have been his sales that it is not probable that his rights could be purchased today for a million dollars. A year or more ago a San Francisco "savant" introduced to a waiting world the electroscope, not in its familiar and accustomed usage but as a means for diagnosing human ills. "See what new marvel science has given us!", said the uneducated, and flocked in crowds to clinics set up in every large city in the land.

Yesterday it was the horse-chestnut carried in the pocket, today it is the electroscope or the magnetic horse-collar. Tomorrow it will be something else. Is there any definite contribution which the high school can make toward safeguarding the general public against frauds purporting to be scientific in nature?

I believe there is and that such contribution lies in fearlessly teaching the underlying facts in the broad realm of science; pointing out the lines of probability; disclosing "blind alleys"; teaching to think straight, always questioning mere opinion. A boy who has wound a simple magnet and energized it with a battery cell of his own making, is not apt to be so ready to pay fifty dollars or more for a similar one made by someone else, nor to expect the impossible to result from its use. The young student who has enjoyed

a brief course in biology in high school, sees no conflict between science and religion. Furthermore he has come upon the invaluable facts of reproduction in the most natural and helpful manner. A pupil who has studied the immutable laws of action and reaction and the conservation of energy, comes someway to expect to have to give if he receives. He has learned to look for causes and to be healthily suspicious of all "something for nothing" proposals, of whatever nature.

If we can fire the few with a passion for the truth at any price, such ones will carry on the work of invention and research through later study. But the majority of our young people in high school go no farther in the study of science, and our contribution to them while in high school should be and can be very definite and very practical.

Applied Science
The Engineer As a Factor

By A. W. BUTLER

City Engineer, Spokane, Washington.

One hundred years ago, the scientist, Faraday, built for his own experimentation a small static electric machine. While working with it, he discovered that electric currents might be induced from one conductor to another. This discovery was tremendously important and vital to the subsequent development in the electric field. But Faraday had been dead many years before his discovery was found to be good for anything except its scientific value. His work meant nothing to civilization until Edison and others of his time found that an application of this scientific principle could be made.

Now, as we look at our streets swarming with automobiles, airplanes in the sky, messages flying everywhere over wires, entertainment and information broadcast through the ether, machinery designed to do almost every conceivable thing that a human being might desire, we realize that these are made possible by the engineer who has applied some scientific principle to the needs of a progressive civilization.

When we think of engineering attainment, we instinctively picture Edison, Fulton, Marconi and Steinmetz as outstanding figures in this wonderful development. Their work is important beyond comprehension; but we must also remember the work of the pure scientists who first discovered the fundamental principles of science upon which these men based their inventions.

For it has been such men as Priestley, who discovered oxygen; Gibbs, who made thermodynamics possible; Napier, who made possible the use of logarithms; Galileo, who discovered the true movements of our planetary system; Pasteur, who found the true source of infectious disease; these men, whose work was not appreciated by the people of their time, have laid the scientific foundation upon which most of the past accomplishments of the engineering profession have been built.

Up until the past few years, the most important scientific discoveries were made by the pure scientist, who worked for the discovery of a principle purely for the sake of science, without any particular conception as to how these principles were to be applied. Then came the engineer with a mind intent upon accomplishing some practical result, and who grasped and used the discovery of the scientist as a means to accomplish his purpose—something for the benefit of mankind—each one of these working alone having nothing in common with the other.

Later, a realization of the advantages of a closer cooperation between the scientist and the engineer brought about such organizations as the American Society for Testing Materials, Engineering Foundation and the National Research Council. These have sought to combine the spirit of research of the early scientist with engineering accomplishment.

In the American Society for Testing Materials alone there are four thousand engineers dealing with hundreds of different scientific problems, each seeking to discover some method of improving the present system. In this organization there are forty-five committees each working on some problem in which he is specially in-

terested. Among the subjects under study at present are:

Nine committees, each studying some different problem in the manufacture and use of steel, iron and their alloys;

Four committees studying non-ferrous metals;

Eleven studying manufacture and uses of cement, lime, gypsum and clay products;

Twenty-one on miscellaneous subjects, such as lumber, coal and coke, electric insulating materials, roads and pavements, waterproofing, etc.

In addition to the talent contained within the membership of the American Society for Testing Materials they have the counsel and cooperation of the United States

Bureau of Chemistry,
Bureau of Roads,
Bureau of Mines,
Bureau of Standards,
Forest Products Laboratory and
Watertown Arsenal.

If the discoveries of such scientists as Faraday, Priestley, Napier and Pasteur, working sigle-handed, can bring about such wonders as has been accomplished in electricity, chemistry, mathematics and sanitation, what may we expect of such a group of technical men as I have just outlined, consisting of the most scientifically trained men in the world, banded together in such organizations as these for the purpose of advancing scientific research to promote engineering attainment — the scientist and the engineer working hand in hand for the accomplishment of a common purpose?

BLISTER RUST CONTINUES TO SPREAD

The present season has proven to be one especially favorable for the spread of White Pine Blister Rust. This fall the disease was found for the first time in Idaho. A few leaves on the white stemmed gooseberry, *Groseularia Murmis*, were found infected a short distance northwest of Priest River, Idaho.

Spread into new territory was also discovered in Oregon this fall. Several infections on wild currants and gooseberries were found in Hood River and Multnomah counties.

Leaf Invasions by Bacillus Amylovorus

By F. D. HEALD

INTRODUCTION

Previous to 1915 that phase of fire-blight in which the bacteria enter the leaves through the leaf-blade tissue, rather than by migration through the tissues of the petiole, had not been recognized. In fact, writers in general had made the statement that direct invasion through the leaf tissue was impossible. During the summer of 1915, fire-blight was unusually severe in most of the fruit sections of central and eastern Washington, and the writer had the opportunity to observe the behavior of the disease in the Walla Walla, Yakima and Spokane districts on both apples and pears. What proved to be direct leaf invasions were described for both apple and pear. (Heald, 1915). During the same season special studies of fire-blight were conducted at Yakima by Hotson and in 1916 his report on "fire-blight on pear leaves" was published. (Hotson, 1916). The occurrence of the fire-blight bacteria in the leaf lesions was established in a number of ways: (1) by the occurrence of exudate on the under surface of the spots following humid periods; (2) by microscopic examinations of the diseased tissues; and (3) by the isolation in pure culture of *B. amylovorus* from the diseased tissue. The conclusion that the bacteria present in the leaf lesions were *B. amylovorus* was proved beyond reasonable doubt by (1) inoculations of pure cultures into young apple twigs, with the development of typical twig-blight (Heald, 1915); and (2) the inoculation of pure cultures taken from pear leaves into sterilized green pears, with the production of characteristic fire-blight colonies (Hotson, 1916). While these observations and tests seem reasonably conclusive, direct leaf invasions as a result of artificial inoculations had not been reported previous to the work of Brooks (1926)). Such suc-

cessful inoculations have left no further doubt that under certain environmental conditions, direct leaf invasions may be a regular phase of fire-blight.

Following the epiphytotic of fire-blight which reached its maximum in Washington in 1915 and 1916, this disease gradually subsided. During the summer of 1925 fire-blight appeared again with some of its old-time virulence and direct leaf invasions of both pear and apple were again been in evidence. This recurrence of the leaf-blight phase of fire-blight served to remind the writer that the results of some experimental tests carried out in the summer of 1917 have never been published. A report on this leaf-blight phase of fire-blight was included in the report of the plant pathologist for the 27th Annual Report of the Washington Agricultural Experiment Station, but for some reason departmental reports for that year were not printed.

No mention of direct leaf invasions is to be noted in the treatment of fire-blight of either apple or pear as published in 1917 in the Manual of Fruit Diseases by Hesler & Whetzel. Even some of the more recent publications ignore this aspect of fire-blight in a discussion of the symptoms of the disease. (Reimer, 1925). Direct leaf invasions are, however, recognized in two recent manuals (Whetzel, et al., 1925; Owens, 1924), but one is led to infer from the treatment of the subject that leaf invasions have not been observed under field conditions in the east. If such is the case, the epiphytologic complex which confines this phenomenon to the Pacific Northwest should be of interest.

FIELD EXPERIMENTS

During the summer of 1917 experiments were carried out to demonstrate the possibility of producing leaf invasions of apples and pears by inoculations with pure cultures of *Bacillus amylovorus*. A planting of 3-year-old trees in the Pathologium of the Department of Plant Pathology at the State College of Washington was available for these tests. Previous field observations had convinced the writer that success could be expected only if conditions could be furnished which would approximate those under which the natural leaf invasions occurred. These conditions were interpreted as (1) a very succulent growth induced by an abundance of moisture in a fertile soil; and (2) a period of humid, cloudy weather when the leaves were in a very susceptible condition.

In order to artificially produce the above conditions as nearly as possible, the trees used for inoculations, which had previously been making a very good growth, were surface irrigated for ten days previous to starting the inoculations. Each tree to be used was covered with a muslin shade tent (a frame four feet square and seven feet high) on July 25, and was irrigated by an overhead spray from an elevated pipe line at intervals until July 30, when the inoculations were made. The shade tents and the overhead spray were designed to furnish conditions closely resembling a period of cloudy weather with intermittent rainfall.

The inoculations attempted were of two different kinds: **first**, by dipping the thumb and forefinger in a pure bouillon culture of *Bacillus amylovorus* and drawing them carefully with slight pressure along the leaf margins so as to thoroughly moisten the surface, but taking especial care not to use sufficient pressure to injure the leaf tissue; and **second**, by spraying the foliage with bouillon cultures, using for this purpose a small hand sprayer (Mason fruit jar type).

After making the inoculations the shade tents were replaced and overhead irrigation was continued until August 6, when the tents were removed and the first observations made.

The results of the inoculations are shown in the appended tables.

Table I. Result of leaf inoculations made by rubbing leaf margins with pure cultures.

Variety of host	No. of leaves inoculated	No. of leaves showing infections		
		Aug. 6	Sept. 1	Total
Rome Beauty	Nos. 1- 20	1	8	9
Wagener	" 21- 40	0	5	5
Jonathan	" 41- 60	2	6	8
Bartlett	" 61- 80	4	2	6
D'Anjou	" 81-100	5	3	8

Table II. Result of leaf inoculations made by spraying with bouillon cultures.

Variety of host	No. of leaves showing infections	
	Aug. 6	Sept. 1
Rome Beauty	0	3
Wagener	0	13
Jonathan	0	2
Bartlett	0	3
D'Anjou	0	5

Considering the high temperatures and intense sunshine of the period in which the tests were made, it is not surprising that the number of infections was rather low. It is of interest to note that infections on the sprayed branches did not appear as early as on those in which the inoculations were made by rubbing.

The number of infections per leaf varied from one to a maximum of seven marginal and two central in the inoculations by rubbing. This variation is shown in the appended table.

Table III. Number and position of leaf lesions in artificial infections by rubbing with bouillon culture.

Variety of host	No. of leaves showing infections	No. of marginal lesions	No. of central lesions
Rome Beauty	9	17	5
Wagener	5	6	0
Jonathan	8	7	3
Bartlett	6	14	0
D'Anjou	8	9	2

Field observations under natural conditions had previously indicated that leaf invasions might progress until the bacteria finally advance down the leaf petiole and cause twig-blight. In the tests reported in this paper the number and percentage of leaf invasions which advanced until twig-blight resulted by the migration of the bacteria down the leaf petiole is of special interest. This is shown in the appended table.

Table IV. Percentage of leaf invasions causing twig blight.

Variety of host	No. of leaf invasions	No. causing twig blight	Percentage causing twig blight
Rome Beauty	9	3	33.3
Wagener	5	0	0
Jonathan	8	3	37.5
Bartlett	6	4	66.6
D'Anjou	8	5	62.5

It is worthy of note that in the more susceptible pear varieties the percentage of leaf invasions causing twig-blight was higher than in any of the varieties of apples tested. The absence of any twig-blight in the Wagener should not, however, be taken as an index of resistance, since this is known to be a rather susceptible variety. There is no doubt that with a larger number of tests twig-blight of this variety also would have resulted.

SUMMARY

Field observations have shown two periods, the summers of 1915 and 1925, in which leaf invasions by *Bacillus amylovorus* were of common occurrence in both apples and pears in several of the important commercial fruit sections of Washington.

Leaf invasions in both apples and pears have been produced by artificial inoculations using pure bouillon cultures of *Bacillus amylovorus*.

In some of the leaf invasions the bacteria affected only localized areas, either marginal or central, but in others they advanced throughout the leaf and down the petiole, thus giving rise to typical twig-blight.

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Prolific Seed Production in the Forests of Northern Idaho

By R. H. WEIDMAN

Northern Rocky Mountain Forest Experiment Station,
U. S. Forest Service.

It is known in general that nature provides abundantly in the way of seed production for the regeneration of our forests. It is doubtful, however, whether it is realized how stupendous is the quantity of seed actually produced. The forester in northern Idaho is interested in the abundance of seed crops as an incident in his problem of reproducing the forest after logging and after forest fires. This problem embraces not only amount and frequency of seed crops, but also viability of seed, germination, mortality and establishment of seedlings. It has to do also with character of trees to leave standing as seed trees at the time of logging.

The present space permits giving only some of the facts resulting from investigations which indicate the amazing amount of seeds produced in the western white pine forest of northern Idaho. This is a type of forest which is characteristically dense and mixed, and in which the associates of western white pine are western larch, Douglas fir, western hemlock, western red cedar, Engelmann spruce, and lowland white fir. All of these species are fairly prolific seed bearers and produce good cone crops every three to five years. Light to medium crops are produced in the intervening years, with fail years now and then for some of the species.

It should be kept in mind, in this connection, that nature does not make effective use of all the seed that ripens in the forest. It is only when man or fire disturbs the natural conditions that a small portion of the seed produced is used in the regeneration of the stand. The vast quantity of the seed borne by the virgin forest in seed crop after seed crop, with an exception to be mentioned later, goes practically unused. The seed of the successive crops either becomes buried in the forest floor or a certain amount of it germinates and produces seedlings which live a year or two and then die for lack of light. In cases where the overhead shade is not too dense, however, a few seedlings of the most tolerant species, like cedar and hemlock, survive and grow slowly into an understory stand. But much of the seed that falls on the forest floor becomes covered with the annual shedding of dead needles and forms an accumulation in the duff which the foresters in this region have referred to as stored seed. It is the portion of this accumulated seed that has fallen in the years immediately preceding removal of the timber that furnishes the one exception of effective use of seed produced by the virgin forest. There is some evidence that some of this seed retains its vitality through several years of storage and germinates when the forest is

cut or burned. It thus becomes useful in helping to regenerate the forest.

The great quantity of seed which accumulates in the duff under the virgin forest is illustrated by an investigation in which a number of samples of duff were collected systematically and the seed sifted out and a portion of it germinated in the greenhouse. At 52-foot intervals on two strips through a 150-year-old mixed white pine forest a total of twenty-six samples of duff were collected. Each of these comprised the top layer of duff two inches deep and two square feet in area.

On one strip the total number of seeds recovered from the duff amounted to 1,286,900 per acre; on the other strip it amounted to 3,618,200 per acre. Altogether seeds from eight species were found in mixture. In the case of the second strip, the number of seeds per acre by species amounted to 2,978,000 for western red cedar, 301,700 for western white pine, 184,300 for white fir, 134,000 for western larch, and less amounts for the remaining species in mixture. These seeds, of course, were the accumulation of several seed-producing years.

The greenhouse tests of these seeds showed germination per cents of 11.8 for the cedar and 12.7 for the white pine, with germination for the other species less than 4%. These figures represent germinable seeds to the number of 38,300 white pine and 351,400 cedar per acre.

Another investigation indicates the quantity of seed produced as reflected by the natural germination of seedlings the first year following a prolific seed crop. In this case a 6-acre area containing 62 quadrats was located in a stand of timber which had been destroyed by fire in 1926. Here the forest fire prepared a most favorable seed-bed condition without destroying the seed crop on the trees. The fire occurred in August and the cones opened and shed their seed shortly after the fire was out. The examination of the quadrats in July, 1927, showed a total of 575,000 seedlings per acre. The number of these by species was as follows: 329,000 cedar, 207,000 hemlock, 11,500 white pine, 11,000 larch, 10,000 Engelmann spruce, 6,000 white fir, and 500 Douglas fir.

In this instance it is fairly certain that the great bulk of the seedlings did not come from accumulated seed, for over most of the area the fire burned the duff clean to the mineral soil and thus destroyed the stored seed. As a result of this, there was no other source of the seedlings than from the prolific seed crop of the preceding autumn.

The amount of seed actually produced in a single seed year as determined by collection, count, and germination test is indicated by a study of this sort made in the case of western white pine. This showed that in a moderately good seed year mature white pine stands produced 75,000 to 150,000 germinable seeds per acre. There are no similar figures available for the other species, but judging from the above experiments such prolific seed bearers as cedar and hemlock would easily produce three or four times as much as white pine.

Although the wonderfully heavy catch of 575,000 seedlings per acre on the sample plot here cited serves well to illustrate nature's lavish provision for reproduction, it is desired to caution the reader not to take this as an example of what ordinarily happens after forest fires. The usual aftermath of the severe forest fires in this region is bare and blackened land which is rather slowly reclothed with forest growth. This area, however, illustrates one of the rare coincidences of favorable conditions for regeneration when removal of the virgin forest occurred simultaneously with a most prolific seed crop, and this in turn was followed by an unusually moist summer highly favorable to germination and survival of seedlings. But even in this case, successful establishment of the young forest is not yet assured. For this nature must provide not too dry a summer next year. A protracted drought in the second year before the roots of the small seedlings have penetrated sufficiently deep would cause an exceedingly heavy mortality which would leave the area only moderately well off from the standpoint of young growth.

These latter remarks indicate indirectly the reasons for the enormous amount of seed produced by the trees. If it were not for this and the ability of some of the seed to remain viable a few years, the survival of the forest after logging and devastating fires would be extremely doubtful in the face of the frequent lack of coincidence of good seed years or ripe seed crops with logging and burning, and in the face of the rather unfavorable climatic conditions of the average growing season for getting the young seedlings safely started in life.

PROGRAM

of the

FOURTH ANNUAL MEETING
NORTHWEST SCIENTIFIC ASSOCIATION

December 28-29, 1927

Davenport Hotel

Spokane, Washington

REGISTRATION DESK
Mezzanine Floor, Davenport Hotel

PRESIDENT

L. K. Armstrong
722 Peyton Building
Spokane, Washington

VICE PRESIDENT

E. C. Johnson
State College of Washington
Pullman, Washington

SECRETARY-TREASURER

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Cheney, Washington

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M. A. Brannon, University of Montana, Helena, Montana
Thomas Large, The Lewis and Clark High School, Spokane, Washington
M. F. Angell, University of Idaho, Pocatello, Idaho
J. E. Kirkwood, University of Montana, Missoula, Montana

NEW MEMBERS

Membership is open to anyone paying the annual dues of one dollar. Members receive without additional cost regular issues of NORTHWEST SCIENCE, the official organ of the Association.

HEADQUARTERS

The Davenport Hotel will be the headquarters and all meetings, except one, will be held in the hotel rooms, the exception being that of the Geology-Geography Section at 10:30 a. m., Thursday, Dec. 28, which will be held in the Auditorium of the John W. Graham Company's building.

REGISTRATION

The Registration desk will be found on the Mezzanine Floor. All old members should register and receive their official badges for the meeting. At the same time they should see if their dues are paid for the year. New members should fill out an application card and pay the annual fee. Visitors are requested to register and secure a visitor's card.

Registration will begin at 9:00 a. m., Wednesday, and will continue until Thursday noon. All are urged to register as early as possible.

BREAKFAST—LUNCHEONS ANNUAL DINNER

There will be a Sigma Xi breakfast for members and their families Thursday morning, Dec. 29, at 8:00 o'clock. Reservations may be made at the registration desk until Wednesday evening, 75 cents per plate.

A joint luncheon will be had Wednesday noon, in the Hall of the Doges, the Associated Engineers of Spokane and the Northwest Scientific Association participating. Per plate 65 cents. H. Y. J. Coleman, Acting President, U. of British Columbia, will address the group. Subject: "The Canadian University Tradition."

Members of the Eastern Washington Historical Society and of the Northwest Scientific Association will lunch together informally on Thursday noon in the East Banquet Hall. Per plate 65 cents. There will be an address by one or more speakers.

Tickets for the Annual Dinner at 6:30 p. m. Wednesday in the Elizabethan Rooms should be purchased at the time of registration. Per plate $1.50 or reservations may be made by mail prior to the meeting by writing the Secretary, J. W. Hungate, Cheney, Washington. Members and their friends are invited to attend.

Condensed Schedule of All Meetings

WEDNESDAY, DECEMBER TWENTY-EIGHT

9:00 A. M.—Registration: Mezzanine Floor.

10:30 A. M.—General Session. Elizabethan Rooms A. B. C.

12:00 Noon —Luncheon with Associated Engineers. Hall of the Doges.

2:00 P. M.—Botany-Zoology. Elizabethan A.
Chemistry-Physics. Elizabethan D. E.
Education. Room 200.
Forestry. East Banquet Hall.
Geology-Geography. Elizabethan B. C.
Social Science. Mandarin Room.

3:30 P. M.—General Session. Medical Program. Elizabethan A. B. C.

6:30 P. M.—Annual Dinner. Elizabethan Rooms.

THURSDAY, DECEMBER TWENTY-NINE

9:00 A. M.—General Session. Elizabethan A. B. C. Business Session.

10:30 A. M.—Education. Tent B.
Engineering. Tent C.
Geology-Geography. Graham's Auditorium.
Plant Pathology. Tent A.

12:00 Noon —Luncheon with Eastern Washington Historical Society.
East Banquet Hall.

2:00 P. M.—General Session. Elizabethan A. B. C.

3:00 P. M.—Botany-Zoology Elizabethan A.
Chemistry-Physics. Elizabethan D. E.
Forestry. Elizabethan B. C.
Geology-Geography. East Banquet Hall.
Plant Pathology. Room 200.

General Sessions

WEDNESDAY, DECEMBER TWENTY-EIGHT

10:30 A. M.—General Session. Elizabethan A. B. C. President L. K. Armstrong, presiding. Address: Some Forest Problems of the Northwest, Particularly as they relate to Sciences other than Forestry—T. T. Munger, Director Wind River, Oregon, Experiment Station.

12:00 M.—Joint Luncheon with Associated Engineers of Spokane. Hall of the Doges. Address by H. Y. J. Coleman, Acting President, U. of British Columbia. Subject: "The Canadian University Tradition."

3:30 P. M.—General Session. Medical Section. Elizabethan Rooms B. C.
George A. Downs, Spokane, Washington, Chairman. ———— Secretary.

PROGRAM OF MEDICAL SECTION

It is not expected that the public generally is or will be so well advised on subjects relating to human welfare as to dispense with the physician or the surgeon, but it is the duty of every person to know something of the ailments which mankind is subject to, their possible time or opportunity of occurrence, symptoms, best methods of avoidance or care. Mastering these items the intelligent person will understand the importance of calling in the specialist and it is to that end that we have asked the authorities who appear on the Medical program to address the members, the event being of sufficient importance to warrant the holding of a special session with no other simultaneous program. We bespeak for this group a large and attentive audience and hope to have full discussion. No other subjects are of such vital importance as those concerned with the life and health of humankind.

1—Accessory Sinuses of the Nose—L. L. Parcell, M. D., Spokane, Washington.

2—Anomalies of Ocular Muscles—Clarence Veasey, M. D., Spokane, Washington.

3—Heart Pain—Charles M. Anderson, M. D., Spokane, Washington.

4—Some of the Reasons Why Abdominal Diseases Should Not Be Neglected—H. P. Marshall, M. D., Spokane, Washington.

5—Cholecystography—Joseph Aspray, M. D., Spokane, Washington.

6:30 P. M.—General Session. Annual Dinner. Elizabethan Rooms.
President L. K. Armstrong, Chairman.

Address of Retiring President, C. H. Clapp, President University of Montana, Missoula, Montana.
Subject: National Resources and International Problems.

THURSDAY, DECEMBER TWENTY-NINE

9:00 A. M.—General Session. Elizabethan Rooms A. B. C.
President L. K. Armstrong, Chairman.
Business Meeting. Reports of Officers and of Special Committee:
On Larger Facilities for Research and Publication—J. E. Kirkwood, University of Montana, Missoula, Montana.
Election of Officers and Councilors.

12.00 M.—Luncheon with Eastern Washington Historical Society. East Banquet Hall. Per plate 65 cents.

2:00 P. M.—General Session. Elizabethan Rooms A. B. C.
Vice President E. C. Johnson, State College of Washington, Pullman, Washington, Chairman.
Address: Sources for Scientific Study of Pacific Northwest History—T. C. Elliott, Walla Walla, Washington.

PROGRAMS

of

Sectional Meetings

WEDNESDAY AND THURSDAY, DEC. 28-29, 1927

Rooms (and Tents) are in the Davenport Hotel, Mezzanine Floor.

BOTANY-ZOOLOGY SECTION

Ellis B. Harris, Spokane University, Spokane, Wash., Chairman.

Nettie M. Cook, Lewis and Clark High School, Spokane, Wash., Secretary.

The purpose of the Botany-Zoology Section is threefold: First, to encourage research in the biological field. Second, to provide occasion for the interchange of ideas, which is afforded at the meetings. Third, to provide a channel of publication, which is afforded in the columns of Northwest Science. Members of this section are justly proud of the high type of contributions which have been made to its programs. The unusual opportunities which are offered by the Northwest should encourage research and exploration. We are in a comparatively new field. While much has been done, much remains to be done. No investigator but is struck with the magnitude of opportunity for investigations of a local character. On the second point mentioned above, there is obvious need for interchange of ideas and findings. We are poor indeed without the discoveries of our neighbors. No biologist but may be of real service to his fellow biologists by making full reports of his findings. It occurs that it would be well for the Section to undertake the systeuatic collection of data on Northwes flora and fauna. This can be accomplished in part at the meetings, and in part by the collection of reports by a committee appointed for that purpose. There is not a member of this Section but possesses information of value to every other member if it were only reported. What can be done about this? Think it over and be prepared to make a suggestion at the December meeting.

WEDNESDAY, 2:00 P. M.—ELIZABETHAN ROOM A

1—The Inheritance of Growth Habits in Winter Wheat Hybrids—E. F. Gaines, State College of Washington, Pullman.

2—Biological Studies Conducted in a Dying Lake—M. A. Brannon, Chancellor, University of Montana, Helena, Montana.

3—Some Fossil Mammals of Washington—H. S. Brode, Whitman College, Walla Walla, Washington.

4—Hydrogen Ions of the Cell Sap of Different Ages of Coniferous Trees—Floyd W. Gail, University of Idaho, Moscow, Idaho.

5—Notes on Some Forest Seedling Experiments in the Rocky Mountains—J. E. Kirkwood, University of Montana, Missoula, Montana.

THURSDAY, 3:00 P. M.

1—Development of Pigment in Apples—J. R. Magness, State College of Washington, Pullman, Washington.

2—The Distribution of the Hungarian Partridge in North America and the Factors Which Limit It—D. J. Leffingwell, State College of Washington, Pullman, Washington.

3—The Micro-organisms of the Lakes of Glacier National Park in Relation to Fish Food M. J. Elrod, University of Montana, Missoula, Montana.

4—A Final Report of Hay Fever Plants of Washington, Oregon, Idaho, Wyoming, Utah and Colorado—T. A. Bonser, North Central High School, Spokane, Washington.

5—What Makes Entomology Economic?—R. L. Webster, State College of Washington, Pullman, Washington.

CHEMISTRY-PHYSICS SECTION

J. R. Neller, State College of Washington, Pullman, Washington, Chairman.
Alonzo M. Martin, University of Idaho, Moscow, Idaho, Secretary.

By the aid of chemistry and physics we have been able to arrive at the solution of structure of matter, the conquering of which, the open door to a long vista of otherwise unsolvable problems invites the student to the ever green fields of science. Through these agencies it is believed we are started on a journey of human progress whose course at least, is indicated by the following papers but the length of which is beyond the ken of man.

WEDNESDAY, 2:00 P. M.—ELIZABETHAN ROOMS D. E.

1—The Effect of Horns of Short Length on the Intensity of Sound from a Telephone Receiver Used as a Loud-Speaker—B. L. Steele, State College of Washington, Pullman, Washington.

2—Organic Media as Filters in the Ultra-Violet—Thomas M. Dahm, University of Idaho, Moscow, Idaho.

3—Orientation in the Benzene Ring—Bromination of 2-amino-resorcinal dimethyl-ether—H. Linford and A. Levine, State College of Washington, Pullman, Washington.

4—Comparison of Incident and Emergent Photoelectron Velocities from Thin Films of Platinum—H. B. Briggs, State College of Washington, Pullman, Washington.

5—The Rate of Precipitation as a Function of the Concentration of a Colloidal Solution—J. L. Culbertson, State College of Washington, Pullman.

THURSDAY, 3:00 P. M.

1—A New Type of Viscometer—B. L. Steele, State College of Washington, Pullman, Washington.

2—The Extraction of Essential Oils—C. M. Brewster, State College of Washington, Pullman, Washington.

3—Apparatus for Demonstrating the Effect of Astigmatism of a Thick Converging Lens—B. L. Steele, State College of Washington, Pullman, Washington.

4—A New Method for Smelting Sulfide Ores—G. F. Clukey, Lewis and Clark High School, Spokane, Washington.

5—Conductivity of Mucic Acid—Alonzo W. Martin, University of Idaho, Moscow.
C. R. Stillinger, Office of Blister Rust Control, Spokane, Washington, Chairman.
R. E. Myers, Office of Blister Rust Control, Spokane, Washington, Secretary.

EDUCATION SECTION

Arthur Kohlstad, State Normal School, Bellingham, Washington, Chairman.
————————, Secretary.

The Education and Psychology Section of Northwest Scientific Association occupies a unique field. In a way it may be a forum for advanced educational ideas in which any one whether engaged in public education or not may be heard. Also here may be presented for review of colleagues ideas of educational workers in the colleges and universities which are not matured to the point of general adaptation to public schools and researches in special subjects which do not interest the great body of teachers.

The conviction is growing that radical changes in methods of treatment of sciences must be made if we are to retain childish inquisitiveness and curiosity through the years of bookish drill. The conservatism of systems can be better met in an independent forum of this character than elsewhere. It is hoped that the Section may grow and fill this special need in the educational field.

WEDNESDAY, 2:00 P. M.—ROOM 200.

1—Review of Experimental Work to Date in Prediction of Teaching Success—Raymond F. Hawk, State Normal School, Cheney, Washington.

2—Fitting the Curriculum for Part Time Education—S. G. Witter, Principal Part Time School, Spokane, Washington.

3—Aims and Purposes of Collegiate Education in Agriculture—E. C. Johnson, State College of Washington, Pullman, Washington.

4—What Night School Students Study and Why—Frank H. Arnold, Principal Night School, Spokane, Washington.

THURSDAY, 10:30 A. M.—TENT B.

1—Teaching Science to Adults—F. F. Nadler, State College of Washington, Pullman, Washington.

2—Evaluation of the Use of Certain Mental and Educational Tests for Purposes of Classification—A. D. Hollingshead, State Normal School, Cheney, Washington.

3—Scientific Technique as Creator of Modern Civilization—O. C. Pratt, Superintendent City Schools, Spokane, Washington.

ENGINEERING SECTION

A. D. Butler, Secretary Associated Engineers of Spokane,
Spokane, Washington, Chairman.
————————, Secretary.

The progress of civilization in the past century has been brought about largely by the advancement in the sciences. And one of the main agencies whereby the scientific principles have been turned into channels for the practical benefit of the human race is the Engineering Profession. It is therefore fitting, indeed, that the Engineer humbly pays his respects to the Scientist, for none are better qualified to value the worh of scientific discoveries than is he who sees them actually applied to the needs of a people and for the advancement of a civilization.

Although we have been accustomed to think of the work of the scientist as being entirely different from that of the Engineer, we often find that some of our greatest scientific men were Engineers, so it is fitting and proper that the Engineer should take his place among the other members of the Northwest Scientific Association and add his contribution and offer his services to the advancement of a cause of common interest.

THURSDAY, 10:30 A. M.—TENT C.

1—Water Resources of the Pacific Northwest—G. L. Parker, U. S. Geological Survey, Tacoma, Washington.

2—The Science and Application of City Planning—A. D. Butler, City Engineer, Spokane, Washington.

3—Suspension Bridges—Ivan C. Crawford, Dean of College of Engineering, University of Idaho.

FORESTRY SECTION

C. R. Stillinger, Officer Blister Rust Control, Spokane, Washington, Chairman.
R. E. Myers, Officer Blister Rust Control, Spokane, Washington, Secretary.

The purpose and objectives of the Forestry Section of the Northwest Scientific Association may be briefly summarized as follows:

(1) To group all foresters into one organization. Since Forestry is a science in itself any organization which comprehends the inclusion of all scientists in this region must include those engaged in the problems of Forestry.

(2) To bring the forester and those interested in forestry in contact with other scientists not only for their benefit but for the benefit of other scientists. Forestry makes demands upon every branch of science. Every branch of science affects forestry.

(3) To disseminate information regarding forestry in the region. The forestry information issued can be much more effective if it is dealt wtih as a local problem separate from the general national problem. Every individual is affected in some way by forestry. Every individual has an actual economic interest in our forests in this region because the vast majority of the forested area in this region are publically owned. Further, the present and future of our forests are determined almost entirely by what the public says shall be done. In order to do this properly he must be informed regarding the vast resources which he directs and what should be done to properly manage them.

(4) To coordinate the agencies in this region which are directly engaged in Forestry work. Each one is working toward the accomplishment of particular objects. Several are working independently toward the accomplishment of the same thing. There is no agency which centralizes and consequently coordinates the activities of all. If all of these groups can be coordinated into a general plan and each do his bit in that plan much more can be accomplished. Whether it be in education, legislation or research there is need for coordination.

(5) To offer an opportunity to each and every individual, young or old, trained or untrained, to belong to, take part in and support an organization interested in forestry. Some individuals can supply information, others will obtain information, all will disseminate information either by word of mouth or by aiding to finance the publication of information. There is a plan for all and work for all. Each can aid in his own particular way.

(6) To give aid to and support the purposes and objectives of the Northwest Scientific Association.

WEDNESDAY, 2:00 P. M.—EAST BANQUET HALL.

1—Forest Research Activities in the Northern Rocky Mountain Region—R. H. Weidman, Director Rocky Mountain Experiment Station, Missoula, Montana.

2—Non-indigenous Yellow Pine Plantations in Northern Idaho—Gerhard Kempff, Priest River, Idaho.

3—Polyporus anceps as Cause for Red Ray Rot in *Pinus ponderosa*—E. E. Hubert, School of Forestry, University of Idaho, Moscow, Idaho.

4—New Type of Defect in Western White Pine Timber—E. E. Hubert.

THURSDAY, 3:00 P. M.—ELIZABETHAN B. C.

1—The Life History of a Western White Pine Stand—Robert Marshall, Rocky Mountain Experiment Station, Missoula, Montana.

2—The White Pine Blister Rust Problem in the Inland Empire—C. R. Stillinger, Office of Blister Rust Control, Spokane, Washington.

3—How Can Forest Management and the Policy of Continuous Production Aid in the Control of Blister Rust—E. E. Hubert, University of Idaho, Moscow, Idaho.

GEOLOGY-GEOGRAPHY SECTION

V. R. D. Kirkham, University of Idaho, Moscow, Idaho, Chairman.
H. E. Culver, State College of Washington, Pullman, Washington, Secretary.

There are no more fascinating sciences than those relating to geology and geography; or which, in their ultimate analyses have greater bearing on human life and activities; and while it is true that climate has much to do with civilization, geography has its share in determination of climate and no nation is great without its economical geological resources, the scarcity of which has always been a source of national concern, fruitful of international jealousies, sometimes resulting in strife. History and structure are the parents of both these subjects, chemistry and physics being their grandparents. People are prone to think that geology is not an exact science and equally assume that geography is an unchangeable feature, both assumptions being entirely wrong. The papers here comprehend a variety of subjects, several of which are new as to locus, some even adding to our information as to time, place or fact. The audience and the reader are invited to discuss these papers and to add data of their own observations. A wealth of information has been added during the past few years to our knowledge of local geology and some of these papers elaborate that information.

WEDNESDAY, 2:00 P. M.—ELIZABETHAN ROOMS B. C.

1—Physiographic Development of the Cabinet Range and the Adjacent Ranges—A. L. Anderson, University of Idaho, Moscow, Idaho.

2—Recent Investigations of the Cheney Moraine—C. W. Freeman, State Norman School, Cheney, Washington.

3—The Craters of the Moon National Monument—W. D. Marks, University of Idaho, Moscow, Idaho.

4—Where Are the Fossils of Washington?—Harold E. Culver, State College of Washington, Pullman, Washington.

5—Bottoming of Ore Deposits in the Coeur d'Alene Mining District—Discussion led by J. H. Eby, Spokane, Washington.

THURSDAY, 10:30 A. M.—J. W. GRAHAM & CO. AUDITORIUM (Second Floor)

1—The City of Rocks—J. Melville Johnson, University of Idaho, Moscow, Idaho.

2—Existence of Large Tonnage Ore Deposits in Stevens and Pend Oreille Counties—Discussion led by J. H. Eby, Spokane, Washington.

3—Economic Geography of Hawaii—O. W. Freeman, State Normal School, Cheney, Washington.

4—Origin of the Phenocrysts in Porphyritic Granodiorites of Northern Idaho—A. L. Anderson, University of Idaho, Moscow, Idaho.

5—The Origin of Some Greenstones in Stevens County—W. C. Bennett, State College of Washington, Pullman, Washington.

THURSDAY, 3:00 P. M.—EAST BANQUET HALL

1—The Hoh Problem—H. E. Culver, State College of Washington, Pullman, Washington.

2—Major Structural Features of Idaho—V. R. D. Kirkham, University of Idaho, Moscow, Idaho.

3—Notes on the Geology of the Chewelah Quadrangle—R. H. B. Jones, State College of Washington, Pullman, Washington.

4—Structure of the East Side of the Cascade Mountains—Edwin T. Hodge, University of Oregon, Eugene, Oregon.

5————————E. M. Tardy, Nespelem, Washington.

PLANT PATHOLOGY SECTION

F. D. Heald, State College of Washington, Pullman, Washington, Chairman.
C. W. Hungerford, University of Idaho, Moscow, Idaho, Secretary.

THURSDAY, 10:30 A. M.—TENT A.

Studies which are concerned with plant pathology, in the end, have to do with the financial as well as the physical and moral health of the community, for these studies lead to larger and better production through the eradication of enemies. As time passes and population densifies, with parallel occupation of vacant areas, the demands upon food products will increase and those of the soil will become correspondingly more important. Any one scanning the program prepared by the Plant Pathology Section and here submitted, will quickly be convinced of the value of the information just as they should be gratified that so many scientists are contributing talent and time to the investigations with such evident profitable results. Science is the germ of knowledge.

1—Bean Mosaic Investigation—W. H. Pierce, University of Idaho, Moscow, Idaho.

2—Spore Germination Studies with Cereal Rusts—Wayne Bever, University of Idaho, Moscow, Idaho.

3—Leaf Spot of Salal Caused by *Dascyphagaultheria*—H. E. Campbell, State College of Washington, Pullman, Wash.

4—*Cladosporium* in Relation to Apple Rot—G. D. Ruehle, State College of Washington, Pullman, Washington.

THURSDAY, 3:00 P. M.—ROOM 200.

1—Blue Mold of Apples in Relation to Spray Residues—F. D. Heald, State College of Washington, Pullman, Washington.

2—The Fungous Flora of Normal Apples—G. A. Huber, State Colleeg of Washington, Pullman, Washington.

3—The Microform of *Mycospharella pinodes*—Roderick Sprague, University of Cincinnati, Ohio.

4—The Effectiveness of Organic Mercury in the Control of *Rhizoctonia* of Potatoes—L. E. Miles, State College of Washington.

5—A Bacterial Disease of Lima Beans—R. A. Diettert, University of Idaho, Moscow, Idaho.

SOCIAL SCIENCE SECTION

J. G. Patrick, Spokane University, Spokane, Washington, Chairman.
Ruth West, Lewis and Clark High School, Spokane, Washington, Secretary.

The Social Science Division of the Northwest Scientific Association has four fields of activity: History, Political Science, Sociology, and Economics.

It is the purpose of this section to foster and encourage original research in these fields.

As the section has been newly organized the first real conference of those interested in the social sciences will be held at the December sessions; and there, it is hoped, constructive plans will be laid for a definite program.

Expression of interest and assurances of cooperation have been received from most of the leading educational institutions of the Inland Empire and it is hoped that on December 28th and 29th the social scientists of the Northwest will avail themselves of this favorable opporunity to become better acquainted, exchange ideas, and formulate a program for constructive work.

WEDNESDAY, 2:00 P. M.—MANDARIN ROOM

1—The Direct Primary—C. C. Maxey, Whitman College, Walla Walla, Washington.

2—The Threat and Promise in the Present European International Situation—J. E. Miller, University of Montana, Missoula, Montana.

3—Some First Things in Pacific Northwest History—Thomas Teakle, Lewis and Clark High School, Spokane, Washington.

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Notes on Some Forest Seeding Experiments in the Rocky Mountains

J. E. KIRKWOOD

Some years ago a series of experiments was conducted at the State University of Montana to determine the seeding characteristics of certain American species of conifers and hardwoods. Through the courtesy of the Forest Service seeds were obtained from different sources designed to furnish comparative data of interest when grown side by side under uniform conditions. The data sought were especially on matters of viability and rate of growth. The results of some of these experiments are given below.

Seeds of 24 species of gymnosperms were planted and 29 species of deciduous angiosperms, as follows:

Pinus monticola, Western white pine; *Pinus Lambertiana,* Sugar pine; *Pinus flexilis,* Limber pine; *Pinus contorta,* Lodgepole pine; *Pinus ponderosa,* Western yellow pine; *Pinus Coulteri,* Coulter pine; *Pinus divaricata,* Jack pine; *Larix occidentalis,* Western larch; *Picea Engelmannii,* Engelmann spruce; *Picea Parryana,* Colorado blue spruce; *Tsuga canadensis,* Eastern hemlock; *Pseudotsuga taxifolia,* Douglas spruce; *Abies concolor,* White fir; *Abies grandis,* Grand fir; *Abies magnifica,* Red fir; *Abies balsamea,* Balsam fir; *Sequoia Washingtoniana,* Big Tree; *Libocedrus decurrens,* Incense cedar; *Thuja occidentalis,* Eastern arbor vitae; *Chamaecyparis Lawsoniana,* Lawson cypress; *Cupressus macrocarpa,* Monterey cypress; *Juniperus Californica,* California juniper; *Juniperus virginiana,* Eastern juniper; *Taxus brevifolia, Western* Yew; *Alnus tenuifolia,* Thin leaved alder; *Fagus americana,* American Beech; *Quercus Garryana,* Garry oak; *Ulmus americana,* American elm; *Celtis sp.,* Hackberry; *Toxylon pomiferum,* Osage orange; *Liriodendron tulipifera,* Tulip tree; *Sassafras Sassafras,* Sassafras; *Asimina triloba,* Papaw; *Platanus occidentalis,* Sycamore; *Malus rivularis,* Oregon crab apple; *Prunus Mahaleb,* Mahaleb; *Prunus serotina,* Black cherry; *Prosopis juliflora,* Mesquite; *Cercis sp.,* Redbud; *Gleditsia triacantha,* Honey locust; *Parkinsonia microphylla,* Palo verde; *Gymnocladus dioica,* Kentucky coffee tree; *Robinia pseudacacia,* Black locust; *Hamamelis virginiana,* Witch hazel; *Acer saccharum,* Sugar maple; *Acer macrophyllum,* Broadleaf maple; *Acer circinnatum,* Vine maple; *Acer Negundo,* Box elder; *Diospyros virginiana,* Persimmon; *Nyssa biflora,* Tupelo; *Fraxinus lanceolata,* Green ash; *Fraxinus oregona,* Oregon ash; *Sambucus Mexicana,* Mexican elder.

Most of the seed was sown in the years from 1909-1912 inclusive, principally in 1911 and 1912. The first planting was done by Mr. E. C. Clifford under a cooperative agreement between the Forest Service and the University in the initial days of forestry instruction at the University of Montana, and consisted of beds under lath shelter, eight feet high, giving half shade. In this space were grown most of the hardwoods in the above list. Subsequently comparative studies under this shelter and under a lower shelter and in the open were conducted by the writer.

The natural conditions under which the nursery was established and conducted were those of the semi-arid grassland common throughout western Montana at elevations of 3000 to 5000 feet. The native vegetation is more that of the plains than the prairie type, consisting largely of bunch grass (*Agropyron spicatum*), and of partially xerophytic herbs among which are conspicuous *Balsamorrhiza sagittata, Lupinus sericeus, Lithospermum ruderale,*

Chrysopsis villosa and species of *Artemisia.* The plot lies flat and was exposed to wind and sun and without shelter except as artificially provided.

Missoula has a mean annual temperature of 44° F. and a mean annual precipitation of 15.56 inches. The mean maximum summer temperature is 84° with a rare occasions of 100°. The lowest mean winter temperature is 12.5°, rarely and for very short intervals —20° or lower. Precipitation for the frostless season (May 23- Sept. 18) is about 5.34 inches, the mean of nearly 50 years of observation. For the years occupied with these experiments the precipitation for the mean frostless season ran as follows: 1910, 3.23 inches; 1911, 4.92 inches; 1912, 8.61; 1913, 5.67; 1914, 4.64; 1915, 9.39; 1916, 6.40. The figures for relative humidity for the frostless season at Missoula are available for two years only. For 1911 the mean minimum varied from 21 to 41%, and for 1916 from 18 to 32%. In summer there are occasional days when the relative humidity falls to less than 10%. The mean daily variation varies from 51 to 67%. Evaporation is sometimes as much as 2 inches per week from a free water surface.

The soil is of gravelly composition with clay and a slight humus content in the topmost layer. It has a tendency to bake in drying but shows considerable fertility when kept moist. This upper layer of a foot more or less in depth is underlaid by deep beds of coarse gravel, an old lake bed in fact, with the usual wide range in the size of its particles. Owing to its highly porous character it has little capacity for retaining moisture. Samples taken from the depth of a foot at the end of the dry summer season sometimes are reduced by less than 1% of weight when exposed for weeks to the air of the laboratory, and when heated to 120° C. for two weeks lose but 1.9% of their original weight.

The surface soil was used in the preparation of the seed beds without the addition of fertilizing materials and without other treatment than the necessary operations of tillage and the sprinkling of a thin layer of sand over the beds to reduce evaporation and the encrusting effect of drying. Preparation of the soil for planting consisted of plowing or digging to a depth of 8 or 10 inches and the removal of the larger stones. Slightly elevated beds were formed, 4x12 feet. Upon the surface of these the seeds were usually sown broadcast and the beds thoroughly wetted by sprinkling. The sand was then sifted on to a depth of about two times the least diameter of the seed.

To maintain conditions favorable for germination it was necessary to provide against even temporary desiccation. To this end the beds were enclosed by shelters. The most successful was a low form about 18 inches above the soil. A frame 4x12 feet was adjusted to rest on posts at the corners of the bed. This frame supported laths on top in half shade spacing. As soon as the seeds were sown the frame was placed in position and the sides covered with building paper. The top also was completely closed. This operation secured full enclosure of the bed and a high degree of relative humidity. Little attention was required until the seedlings began to appear in numbers, when the enclosing paper was removed and only half shade from the top maintained during the rest of the season. The response of seedlings to this treatment was normally quick and uniform. At the end of the season the frames were removed and thereafter no shelter was provided. In the second year the seedlings were usually transplanted into larger beds, the preferred practice, or taken directly to the field.

The high lath shelter above referred to was enclosed on all sides by vertical lath with the usual half-shade spacing. This gave the effect of a good forest canopy. It cut down the reflected as well

as the direct light. Under this shelter certain species did better than those under the lower frames where, after the paper was removed, the beds received much light both, direct and reflected from the surrounding soil, and were also more subject to the drying effect of wind. After the first season the plants not under the high shelter were fully exposed to wind and sun. The wind, while seldom of high velocity, was a considerable factor both in summer, and winter; in the latter season this type of shelter was effective also in favoring accumulation of snow over the beds within.

The net weight of the seed received was determined. A part of each lot was then taken for an estimate of the number of such seed to the pound. The figures thus obtained threw some light upon the size of the seed and its quality, especially where seed of the same species but from different localities was compared. An ounce or more in the case of the larger seeds, or a smaller fraction when the seeds were very small was the part chosen in which the seeds were counted and the basis furnished for the estimate of the number in a pound. In order to learn something of the condition of the seed from the standpoint of viability a few dissections were made. One hundred seeds of each species were subjected to the knife test and the number of apparently good seeds noted. This was deemed essential in order to form an estimate of the probable germination response in each case. Indoor germination tests would also have been desirable, but the amount of time available for such work was inadequate for the purpose.

It will be noted from Table 1 that there is a larger percentage of survival under the low shelter in eleven cases, and under the high shelter in seven. The percentage was calculated on the esti-

TABLE 1. The record of seed of twelve species from eighteen localities showing the survival at the end of the first summer (about 4 months).

SPECIES	Source	Viability* knife test %	High Shelter		Low Shelter	
			Seed	% Survival	Seed	% Surviv'l
Pinus monticola	N. Idaho	85	1 lb.	1.25	1 lb.	3.5
Pinus monticola	W. Mont.	91	1 lb.	0.7	1 lb.	3.3
Pinus ponderosa	Idaho	94	4 oz.	28.3	4 oz.	7.7
Pinus ponderosa	N. Calif.	91	8 oz.	40.0	24 oz.	10.4
Pinus contorta	Wyoming	96	4 oz.	0.6	3 oz.	3.6
Larix occidentalis	N. Wash.	43	12 oz.	0.8	12 oz.	5.0
Picea Engelmannii	Idaho	91	1 oz.	0.8	2 oz.	2.8
Picea Engelmannii	E. Wash.	74	12 oz.	0.9	12 oz.	3.0
Picea Engelmannii	Colorado	97	1½ oz.	1.6	2 oz.	9.9
Picea Parryana	S. Colorado	93	1½ oz.	2.0	¾ oz.	1.4
Pseudotsuga taxifolia	W. Oregon	74	12 oz.	7.4	12 oz.	8.9
Pseudotsuga taxifolia	W. Wash.	94	7 oz.	4.8	8 oz.	6.3
Pseudotsuga taxifolia	Wyoming	46	3 oz.	9.5	4 oz.	5.5
Abies magnifica	S. Oregon	49	12 oz.	4.0	12 oz.	5.4
Abies concolor	California	33	3 oz.	2.6	4 oz.	1.9
Sequoia Washingtoniana	California	18	5 oz.	2.2	5 oz.	0.7
Libocedrus decurrens	N. Calif.	41	3 oz.	10.5	3 oz.	3.7
Chamaecyparis Lawsoniana	N. Calif.	78	1 oz.	10.0	2 oz.	18.5

*This column gives the viability of the seed as apparent from physical examination.

mated number of seeds sown. In each case the seed quantities given in columns four and six were taken from the same lot. The exceptions are most marked in the cases of yellow pine, and Douglas spruce from Wyoming and incense cedar. The yellow pine is a species notably intolerant and on that account apparently forced by competition into those habitats less favorable from the standpoint of soil moisture. Field observations show however, that it responds quickly to increase of moisture. That this quality is shared by the seedling of the species should be expected. Its subsequent behavior in these experiments shows a more rapid growth in exposed situations, due probably to its light requirements. The Douglas spruce is a frequent companion of the yellow pine on dry southern slopes in Montana. Seed of this species produced in Wyoming showed response similar to the pine and in larger numbers. This lot of seed appeared to be only 46% viable by physical examination while that of the other lots of this species from western Oregon and Washington indicated viabilities of 74 and 94% respectively. The germination response in these cases as indicated by survival was 7.4 and 4.8% respectively under the high shelter as compared with 9.5 for the Wyoming lot. The incense cedar also endures rather dry situations and its behavior in these operations may have the same explanation.

As pointed out in an earlier paper, (1), the seeds within one year of their production showed from 3-54% defective in different lots and species as determined by dissection, while in the beds none of them showed more than 10.4% viable under the most favorable conditions. This estimate, however, is doubtless much too low, owing to the fact that it was based upon the number surviving at the end of the first season. The percentage of response in germination showed no relation to the percentage of apparently viable seed before sowing. Thus where *Pinus ponderosa* showed 91% viable by dissection, 10.4% actually produced seedlings while, the same species in another lot showed 94% there resulted only 7.7% of seedlings, and in the case of the spruce the figures were respectively 91% and 2.8% for one lot and 74% and 3% for another. The only constant relation revealed by the studies seemed to be that the time required for germination is inversely proportioned to the number of seeds responding, or, in other words, percentage of germination and rapidity of response were directly proportional, a thing to be expected. Of course the rate of propagation in the field under natural conditions must be very much less than under cultural conditions. Seeds of the same species from different sources differ radically in size, weight and viability, facts which must to a large extent determine the place which each species finally occupies in different parts of its range.

Observation of the seedlings through a period of several years shows an acceleration of growth in height after the second year in nearly every case, being least in the Engelmann spruce and most in the larch, while the greatest growth in height at the end of the first season was 4½ inches in the case of the Douglas spruce. In the second year it was exceeded by the larch with 13 inches which was increased to 59 inches in the fourth year. The Douglas spruce at the end of the fourth year had reached a height of 22 inches, the yellow pine 23 inches, the white pine 13, the lodgepole 27, the spruce 16.

The average heights obtained were more significant. Those for the yellow pine at the end of 1, 2 and 4 years were respectively 2, 4 and 18 inches, for the white pine 1, 3 and 9; for the lodgepole 1, 4 and 18, for the larch 1, 8 and 40; for the spruce 1, 2 and 6 and for the

1. Kirkwood, J. E., Forest Distribution in the Northern Rocky Mountains, Univ. Mont. Studies 247, June 1922.

TABLE 2. Maximum heights of seedlings under high and low shelter. After the first year the low frames were removed, leaving the seedlings fully exposed.

SPECIES	Source	Maximum growth in height—inches In 4 months High	In 4 months Low	In 2 years High	In 2 years Exposed	In 4 years High	In 4 years Exposed
Pinus monticola	N. Idaho	1.5	2.25	4.0	4.0	13.0	13.0
Pinus monticola	W. Mont.	1.0	2.0	4.0	3.0	9.0	12.0
Pinus ponderosa	Idaho	2.5	3.0	6.5	5.5	17.0	23.0
Pinus ponderosa	N. Calif.	2.0	2.0	4.0	4.0	11.0	19.0
Pinus contorta	Wayoming	1.25	2.0	5.0	6.5	22.0	27.0
Larix occidentalis	N. Wash.	2.5	2.5	24.0	13.0		59.0
Picea Engelmannii	Idaho	0.5	0.9	2.0	4.0	8.0	10.0
Picea Engelmannii	E. Wash.	0.75	1.25	3.0	6.0	13.0	16.0
Picea Engelmannii	Colo.	0.75	1.25	2.0	3.0	8.0	11.0
Picea Parryana	S. Colo.	1.0	1.5	2.5	3.0	11.0	13.0
Pseudotsuga taxifolia	W. Oregon	3.25	4.5	10.0	6.0*	26.0	22.0
Pseudotsuga taxifolia	W. Wash.	3.25	4.5	11.0	....*	36.0	22.0
Pseudotsuga taxifolia	Wyoming	1.75	2.0	6.0	6.0	13.0	17.0
Abies magnifica	S. Oregon	2.75	4.0	10.0	3.0	30.0	7.0
Abies concolor	Calif.	1.5	1.5	4.5	4.0	13.0	10.0
Sequoia Washingtoniana	Calif.	2.0	1.0	5.0	....*	....	....
Libocedrus decurrens	Calif.	0.75	3.4	6.0	4.0	11.0	12.0
Chamaecyparis Lawsoniana	Calif.	2.75	3.0	8.0	6.0	....*	....*

*Tops winter killed

Douglas spruce 1, 4 and 12 inches. The amount of difference between the maximum and average varied with the conditions. Under high shelter at the end of four months the average seedlings varied from 16 to 60% below the maximum in in height,—average 42.3%. Under the low frames the differences ranged from 16 to 75%—average 40%. Thus the difference between the maximum and average was greater under the high shelter. At the end of two years the average seedling under the high shelter was 36.2% below the maximum, varying from 16-60%. Under full exposure the difference was again less, varying from 16-50%, — the average difference being 31.6%. When the seedlings were four years old, the average under the high shelter were 30.2% less than the maximum, varying from 11 to 55%. Under full exposure the difference was 35%,— varying from 20-45%. Thus the difference between maximum and average tends to grow less with age.

At the end of the first season there was but one case where the maximum growth under the high shelter exceeded that under the lower; there were three cases in which they were equal and fourteen in which the seedlings under the low shelter exceeded those under the higher. Among the averages three cases had the greater height in the high shelter, eleven in the low and three were equal. In the second year the balance swung to the other side, showing ten cases under the high frame with the greater maximum, five under full exposure with greater height and three equal. Among the averages the corresponding figures were 7, 5 and 6. In the fourth year four cases under the high shelter had the lead over the corresponding lot in the lower, but ten cases in the exposed beds were leading, while one remained neutral. The average seedlings were taller under the high shelter in six cases, taller under exposure in five, and equal in six. Some loss was experienced under both conditions through

TABLE 3. Average heights of seedlings under high and low shelter. After the first year the low frames were removed, leaving the seedlings fully exposed.

SPECIES	Source	Average growth in height—inches In 4 months High	In 4 months Low	In 2 years High	In 2 years Exposed	In 4 years High	In 4 years Exposed
Pinus monticola	Idaho	.75	1.25	2.5	3.0	10.0	9.0
Pinus monticola	W. Mont.	1.5	1.0	2.0	2.5	8.0	8.0
Pinus ponderosa	Idaho	1.5	2.0	5.0	4.0	14.0	18.0
Pinus ponderosa	W. Calif.	1.5	1.5	3.0	3.0	7.0	15.0
Pinus contorta	Wyoming	0.5	1.0	3.0	4.0	16.0	18.0
Larix occidentalis	W. Wash.	1.0	1.0	10.0	8.0	.....	40.0
Picea Engelmannii	Idaho	.25	.37	1.5	2.0	6.0	6.0
Picea Engelmannii	E. Wash.	.37	1.5	1.5	3.0	9.0	9.0
Picea Engelmannii	Colorado	.5	1.0	1.5	1.5	6.0	6.0
Picea Parryana	S. Colorado	.75	1.0	2.0	2.0	8.0	8.0
Pseudotsuga taxifolia	W. Oregon	2.5	2.0	5.0	4.0	19.0	12.0
Pseudotsuga taxifolia	W. Wash.	2.0	2.0	8.0	....*	25.0	13.0
Pseudotsuga taxifolia	Wyoming	1.0	1.0	4.0	4.0	10.0	10.0
Abies magnifica	S. Oregon	1.25	1.0	5.0	2.5	15.0	4.0
Abies concolor	Calif.	1.0	1.25	3.0	3.0	....	6.0
Sequoia Washingtoniana	Calif.	1.0	.75	2.5	....*	6.0	....*
Libocedrus decurrens	N. Calif.	0.5	2.0	5.0	3.0	8.0	8.0
Chamaecyparis Lawsoniana	N. Calif.	1.5	2.0	4.0	4.0	6.0	....*

*Tops winter killed

winter killing among the less hardy species. Here also the differences grow less with age. Some species showed much greater susceptibility to the influence of overhead conditions than others. The spruce species seemed largely indifferent to shelter in the average crop, although the leading individuals decidedly favored the open. Both the red fir and the white fir strongly favor the shelter after the first year, a response also notable in the Douglas spruce from the coast, while the lodgepole and yellow pines prefer the open.

All the data included in the tables are from seeds sown in 1912. The seedlings surviving at the end of the first year numbered somewhat over 43,500. During the period from 1912 to 1916 the plantations were subject to some irrigation during the dry period of the summer. After 1916 they were abandoned and the seedlings were allowed to remain in the beds in which they had been sown without any attention whatever. The struggle for survival has resulted in the suppression of many of the young trees and the ascendancy of others. There now remain a number of yellow pines varying in height from three to 11 feet with diameters at the ground from one half to three inches. The lodgepole has reached a height of 12 feet among a number of smaller companions. The larch has reached 8 feet and the Douglas spruce has virtually succumbed to the rigors of the situation. That the larch has survived at all is noteworthy, sensitive as it is to drouth.

The yellow pines are by all odds the most successful trees in this abandoned plantation. After eleven years of total neglect they are still making vigorous growth, in a soil peculiarly difficult for most plants of the region and where no trees of any kind have yet become established by natural means. Efforts to grow the yellow pine in like situations from seeds and transplants without irrigation

has so far proven unsuccessful, but the results here seem to show that the seedlings of this species once thoroughly rooted in the soil may succeed. Recently the University in its program of campus planting has successfully transplanted a number of these trees, 6-8 feet high, with somewhat meager attention to soil condition and water.

Some of the seeds of yellow pine sown in the spring of 1909 grew vigorous seedlings under the high shelter. The following spring these were transplanted into the open in an adjoining plot. These transplants to the number of some 20,000 were grown successfully under irrigation. Some of the stock was utilized for other experiments, but much of it still stands where it was placed in 1910. Like the seedlings above discussed these also were neglected and allowed to grow, as best they might, unaided. The tallest of these now measures 12 feet, and the average is about 7 or 8. These trees in this season (1927) ripened their first crop of cones. The cones are rather smaller than the average for the species but the seeds are unusually large and heavy. Thus *Pinus ponderosa* has been raised from seed to seed under observation in 18 years. The lodgepole growing from seed sown in 1912 bore fruit seven years ago, or at the end of 8 years from the seed.

Experiments on field planting were conducted on the yellow pine only. Three plots, each about 60 feet square, were laid out on the grassy slope of a mountain facing the west and southwest, at an altitude of about 4000 feet. One of these areas, No. 1, was located in the most favorable spot that could be found on the two miles of mountain side extending from north to south. This spot by reason of a slight depression, had a richer soil and retained its moisture later than the other places. The two other plots, Nos. 2 and 3, lay on the most difficult slopes and rocky situations. Upon each of these areas small yellow pines were planted in each of three successive seasons. Those planted in the first season were put out about the last of April, 1910, and were one-year-old seedlings, 100 on each area. The summer of this year was unusually dry and not one of the 300 survived. About the first of April of the following year the same areas were again planted to the number of 300. Areas 1 and 2 were set to two-year-old pines which had been one year in the transplant beds and had developed good root systems. Area 3 was planted, 40% to the same stock and 60% to two-year-old seedlings. Before the close of this season a grass fire destroyed all but a few of these plants, but of those which escaped two came through the season in good condition. In 1912 the areas were again planted, this time 110 spots on Area 1 and 50 spots on Areas 2 and 3. One, two or three one-year-old seedlings were placed on each spot. Inspection the following October showed that 24.54% of the spots planted came through the season with living trees, and 26.19% of the total number of seedlings planted. Some spots showed no trace of the trees planted; these may have been obliterated by the trampling of stock. The mountain side, however, was only slightly grazed. The trees in certain other spots stood untouched, but dry and crisp. Similar results were obtained on Areas 2 and 3, 21.03% in the former and 24.05% in the latter case being the number surviving the first season, and total extinction the final result. It was thought that if the yellow pine could come through one season and once establish its roots in the soil, that it might be able to survive, but such seems not to be the case. In all experiments the planting was conducted with great care. As the trees were taken from the beds their roots were bathed in mud, from which they were lifted in a few moments and wrapped in wet burlap and conveyed to the planting areas half a mile distant. The soil was in good condition for planting and in 1912 the planting was followed by

a period of rain. In some cases stones were set up to shelter the young trees from wind and sun. Despite these efforts few of the trees seemed to prosper; they remained low and stunted, putting out a few fascicled leaves on a half inch increment of stem as the total of their accomplishment during the second year of their age, while their erstwhile companions in the nursery grew several vigorous inches of stem and a full brush of leaf clusters.

The planting of seedlings and transplanted pines was varied in a number of ways, especially with reference to the kind of nursery stock, but always with the same result. In all about 1000 young pines were planted. Several seeding experiments shared the same fate. Small plots 20 feet or more square were shown with seeds of *Pinus ponderosa*. These plots were variously located as to soil, exposure and seepage from melting snow. Some thousands of seeds were planted and covered with soil. So far as could be determined not a single seedling resulted.

The broadleaf (angiosperm) seedlings were more difficult to manage than the conifers. Several thousand plants were produced, but the total result to show was small. They suffered from drouth and in the final abandonment of the plantation completely succumbed. Five hundred trees of box elder, beech, elm and hackberry were planted on the hillside near the nursery, but all died the first season. Winter killing accounts for some losses in both groups. This appears to be due more to the desiccation than to cold in the case of some species. Native trees in wind swept situations at high altitudes are killed back at the top, while their branches under the snow suffer no apparent injury. The State University attempts to grow various hardwood trees of the middle west in the landscape scheme of the campus. A few species of oak, elm, ash, maple and linden meet with fair success. Others show difficulty in becoming adjusted to the environment, making slow and unsatisfactory growth or eventually dying out. They are all irrigated during the growing season and the average winter temperature is higher than in that region to which many of them are native. The explanation seems to lie in the high atmospheric saturation deficit frequently occurring both in summer and winter in this region.

SUMMARY

1. Over 50,000 seedlings were the subject of experiments lasting over a period from 1909 to date.
2. There seemed to be different ecological habits and requirements pertaining to trees of the same species derived from seed grown in different climates and widely sundered regions. Seedlings reflect the nature of the environment to which their parents have long been accustomed.
3. Results of these experiments indicate that the species, and sometimes the localized form of the species, is a law unto itself. Species respond differently to the same methods and each, for the best practical results, must be managed individually.
4. Seed testing by dissection in the cases studied bears no constant relation to the response in germination. In the soil the seedlings which come through in the least time come in the largest numbers.
5. Lodgepole pine came to fruition in 8 years from the seed, the yellow pine in 18.
6. Attempts at afforestation of a semi-arid western grassy slope by means of seeds, seedlings and transplants of yellow pine met with negative results.
7. Cause of failure in the growing of many species of hardwoods and some conifers in the northern Rocky Mountains must be looked for in the moisture relations rather than in those of temperature.

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The Hungarian Partridge in North America and the Factors Limiting its Distribution

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The discontinuity in distribution of the Hungarian partridge in North America leads one to believe that there must be some strong factors which limit its range. Why is this species abundant in the West and rare in the eastern states? I think it is safe to say that there are more Hungarian partridges in eastern Washington than in that part of the United States east of the Mississippi. The birds have been released in large numbers in the East and yet they do not seem to thrive.

Probably it would not come amiss to mention the original home of the partridge. The birds apparently are native to Northern Europe and found today in Great Britain, France, Germany, Austria-Hungary, and part of Russia. Here they range over the farms and gardens, nesting in hedgerows and feeding in the turnips and wheat. In Great Britain partridge live near the seashore as well as inland and from Lands End to Scotland. On the large estates they are guarded closely against vermin and during the hunting season are driven to the guns. Partridges are typically birds of the open fields, taking to hedgerows and cover only in extreme cases.

The partridge has been established in North America only within recent years. It was first introduced in the East by early settlers, but it did not prosper and soon died out. From about 1905 to 1912 was a period during which the birds were planted in large numbers, but only in the western states did they seem to catch hold again. Since 1922, due to the publicity which they have had in sporting journals, many eastern states are trying to reestablish them as game birds, though with what success we have yet to learn.

The introduction of the partridge was successful in but eight of the 26 states in which it has been tried. These are Illinois, where introduction was successful in the northern part of the state only, North Dakota. South Dakota, Montana, Colorado, Umatilla, Morrow and Wallowa Counties, Oregon, the central and southern part of Idaho and eastern Washington. The partridges were planted in western Washington, but they did not thrive there. In Canada, the birds succeeded best in Alberta, and spread from there to Saskatchewan and Montana. Partridges were also established in Manitoba and in the Okanogan Valley of British Columbia. In Halifax County, Nova Scotia, the birds are increasing quite rapidly.

In Connecticut, New Jersey, Virginia, Ohio, Indiana and Wisconsin, the species is not increasing. The situation seems to be quite promising in Nebraska since it is reported to be on the increase there, and lack of immediate success is doubtless due to poor planting methods.

In six states where the birds have been introduced, they have not prospered, but soon disappeared. These states are Massachusetts, Rhode Island, Maryland, Kentucky, Iowa and Kansas. What caused their disappearance is not positively known.

What factors are common to these areas in which the partridges thrive? Here in North America, partridges seem to thrive best at elevations over 1000 feet, except for the one record in Nova Scotia. All these areas, with the possible exception of Illinois, are open wheatlands, large open areas with but few hiding places for game enemies. Climate may be one factor, as the birds do not prosper in very humid

areas, such as on the western side of the Cascades. Only one factor can be found common to this continent and Europe, and that is the lack of game enemies, commonly known as vermin.

This last factor seems to be the most important and it is also linked up with the open type of country. In such areas as we find in eastern Washington, there are few hedgerows and consequently poor hiding places for ground vermin, and except in the canyons, there are no nesting places for hawks and owls, so that the enemies of partridge are really scarce. Here in Washington we find such ground forms as weasel and mink uncommon, skunk rare and comparatively few coyotes. The resident hawks and owls are not numerous, and the only common species of bird enemy is the magpie, which is not especially abundant. In New York, one of the eastern States where Hungarians are being introduced, we find entirely different conditions in which the game lives. Weasel and mink are common and the skunk is abundant. The latter is truly one of the worst of game enemies. Foxes are also quite common, even in the more settled parts of the state and the raccoon is not averse to bird eggs. Because of the many wooded areas, since each farmer has his woodlot, hawks and owls are more common than in eastern Washington and the crow is quite abundant. The abundance of vermin rather than the lack of large open fields will, I fear, prevent the partridge from ever becoming abundant in that state.

Eastern Washington has one point in common with Great Britain. The vermin is scarce. On all the large estates in England where the game is preserved for hunting, all forms of vermin are trapped, shot or poisoned. Only the foxes are kept, and they are kept away from the birds by various devices.

The partridges are birds of temperate regions and therefore should not be planted in the southern States nor in the extreme North. There is a belt across the country, corresponding in general to the transition zone of Merriam where partridges and Chinese pheasants seem to thrive and they should never be planted outside of this area.

The areas in which the partridges *do not thrive* are either too far south and hence not in the transition zone or else have an abundance of vermin. The birds will do best in the areas free from vermin.

To summarize then, we find the introduction of the partridge has been most successful in the dry non-forested areas with an elevation of 1000 or more feet above sea level and where the game enemies are rare. The lack of vermin and the large open fields in which the birds may feed are probably the most important factors. The birds should not be introduced outside of the temperate or transition zone.

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Some Fossil Mammals of Washington

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Some thirty localities where remains of fossil mammals have been found in the State of Washington are noted by Dr. O. H. Hay in a recent publication by the Carnegie Institution of Washington. (1)

About twenty species have been identified from the material collected by various persons and found in different museums. These include species of ground sloth, elephants, horses, camels, deer, and bison.

A number of the specimens used by Dr. Hay in preparing his monograph are in the Whitman College Museum at Walla Walla including one type specimen of a new species.

The remains of elephants belonging to the species *Elephas columbi* were found in several places in the state. A lower jaw and fragments of leg bones were found within the enclosure of the Washington State Penitentiary buried to a depth of fifteen feet in fine earth, possibly aeolian in origin. At Quincy, Washington, a tooth, an atlas, and a number of fragments of large bones were found in gravel deposits. Teeth and tusks, the latter consisting of two pieces six inches in diameter and four feet long, along with parts of leg bones were found many years ago at Port Williams in Clallam County.

A portion of a skull from the Port Williams collection differed so widely from other forms that Dr. Hay considered it as belonging to a new species. To this form he gave the name *Elephas Eellsi* after Rev. Myron Eells who with others collected the Clallam County material and presented it to the museum. (2)

Another specimen is a tooth found at Touchet which is of historical interest as well as being biologically valuable. It was uncovered during the excavation for the railroad built by Dr. D. S. Baker in 1873. Dr. Hay classifies this provisionally as *Elephas columbi* but it closely resembles *Elephas primigenius.*

The museum also contains a large vertebra of a bison which is identified as belonging to *Bison latifrons.* There is some question as to the locality from which this came. If it came from Eastern Washington, as is probable, it is important in that it gives new information as to the range of this form.

The remains of mammoths which are in the Whitman Museum are for the most part from Port Williams on the west side of the state and from the Columbia River and its tributaries on the east side. A number of specimens were found at Quincy and others about twenty miles north of Pasco which would be near Ringold. In Walla Walla County specimens were found at Touchet and Walla Walla.

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1. Hay, Oliver P. The Pleistocene of the Western Region of North America and Its Vertebrated Animals. Carnegie Inst. Pub. No. 322B. 1927.

2. Jour. Wash. Acad. Sci. **16:** 154-159, Plate 1926.

Adult Education

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Our educative process is one of constant change. In social development we constantly discover new areas of contact. As fast as we come to these there results some new development of the educative processes to include it. As this process goes on new terms become necessary and old ones become obsolete. Many general terms that had a distinct significance only a few years ago are now about meaningless. Not a year passes by but there arises the necessity to devise a new term specifying some educational activity, and perhaps to limit its application.

A striking evidence of this fact is shown by the effort of the National Society of College Teachers of Education to develop a dictionary and glossary of educational terms whose definitions should be authoritative. One relatively recent arrival on the horizon of terminology is "adult education." Like all such and similar, it is hailed as something new. How eagerly does the public mind grasp at a term in the fatuous hope that it may signify some real progress, only to find that, as from time out of mind, it is merely running to a shibboleth.

In discussing adult education we are immediately confronted, it seems to me, by two problems. These are perhaps issues of logic more than anything else. First, is adult education really something new? The answer is, no. It was old before Moses and Aaron studied the Law. It was old when Buddha and Confucius practiced it. From time immemorial grown-up men and women have been learners, have either been put or have put themselves through effective educational processes. The history of the human mind bristles with many notable examples of adult learners. From Socrates to David Starr Jordan, cultural progress has been stimulated by men who add proof and potency to the adage, "One is never too old to learn." This is a maxim which some folks who are today exulting over adult education as over a new baby, need to think about. They are all respectfully referred to Thomas A. Edison, who at almost seventy-one is still learning with the ardor of a child.

The other horn of our dilemma may be shown by asking—What do you mean by, "adult?" What is an adult, educationally or in any other sense? Our statutes define adults as persons twenty-one years of age. We sometimes popularly differentiate between youth and adult education at the point when people go to college. If we try to make college entrance indicate adulthood, it becomes hard to keep our own proposition from looking ludicrous to ourselves. I think of those hordes of youngsters, ranging from sixteen to twenty years of age, who will pass out of our high school mills next May and June and be putatively qualified to enter our colleges. With all this perhaps we may contrast John Fiske's classical conception that human infancy continues well toward thirty years of age and beyond. Some of us who come to this gathering from college campuses will enthusiastically support his statement. If, however, he is right, we need to attain a different view point with regard to what adult education really is from that which I believe to be popularly held by the teachers and regular folk.

Let me here quote two paragraphs from Professor Hall-Quest: "One's philosophy of life, whether individual or social, imposes delimitations that affect one's conception of education. Is education synonymous with schooling? If so, then only formal and systematic schemes of instruc-

tion can be considered educational. Is education identical with experience? If so, then living itself with its incidents and events, singly or in series, for good or ill, whether in school or out, must be viewed as education, for any act or series of acts performed by a living creature and resulting in his advance to a different point of view or in his employment of a different mode of self-expression perforce will justify the attribute educational."

"The quite common confusion of change and progress in the interpretation of historical movements can easily lead one astray also in the understanding of education. Mere change, of course, does not necessarily involve progress or improvement. Living may revolve about a center of hereditary prejudice and, apart from natural physical development, leave the individual at death in a grave on the site where his cradle rocked, in mute symbolism of the meaning of his stark existence. Experience may or may not be educational. Its educational value depends on the range of improvement that it has provided for the individual or society."

Now after all that, can we define adult education? Try this: The process whereby men and women continue to add to their stock of knowledge and to develop their wisdom by systematic or informal study, observation, or investigation. It is a valuable means by which grown, mature persons manage to maintain an intelligent grasp of the life about them. Many of them strive throughout their lives to educate themselves to where they understand, to quote H. G. Wells, their "relation to the universe." To continue in his strain, they wish to keep up with civilization and civilization is a race between education and catastrophe.

To consider adult education becomes an indispensable condition of contemporary living. Democracy is so dependent upon education that it assumes that men and women not only have developed their intelligences, but that they will continue "intelligent and discriminately poised and abreast of the times throughout life." But adult education has lately come into much sharper and more universal demand than previously for reasons that we can perhaps readily analyze.

First, conditions that tend to put people behind the times culturally have of late years greatly intensified. This is due to the unprecedented rate at which additions to the world's stock of knowledge are being made. It requires an alert, active and dynamic mind to keep *au courant* with the developments in any specialized field of knowledge, not to mention the impossibility of any one's keeping up with them all. Many fields of learning are now well defined and distinguishable that but a few years ago were inchoate, amorphous, and indefinable. Practically every branch of science has been rewritten, some branches several times over since most folks, now in the high midlife tide of time but able to learn very well, were in college, and very much adults. This particularly applies to the present speaker. Twenty-five years ago I attempted to learn a little chemistry. I did learn a very little, too. Now when I try to discuss chemistry with my son apparently he and I are not discussing the same thing at all. In every branch of technology the most casual needs for a superficial, conversational acquaintence almost necessitate relearning the subject.

Second, and corollary to the foregoing, is the development of entirely new branches of learning which did not exist in our youth. The present writer has a certain measure of responsibility for a radio broadcasting station. That radio station commits itself three times a week to what we may call the critical judgment of the world. Yet when I am asked, as I frequently am, some questions about the technicalities involved I find it necessary to call in a technically informed man to see what we are talking about.

So entirely new fields of knowledge have come into the ken of man, since most of us were in what has traditionally been regarded as the teachable age. Their mastery often involves beginning, or re-beginning to learn some simple processes. If they are to be apprehended, many grown-ups must be educated, often from primary stages of learning.

Third, adult education offers an attractive new frontier of learning, one along which we find minds that are freed in large measure from the preconceptions and the misconceptions of youth. Here is a new area for educational effort, created largely by the increase of opportunity for leisure. The question chiefly for institutions interested in helping men and women to keep abreast of their times is: How can we utilize the opportunities of this frontier in the interests of democracy and civilization?

Adult education, it seems to me, should set out systematically to work this new frontier in the interests of society. In view of the status and definition of adult education that I have attempted to give, may we not claim that in the area whatever of knowledge, whatever of stimulus, whatever of directed effort, whatever of challenge to be wise and intelligent, to understand tendencies in the arts, sciences, and technologies that colleges and universities further and advance, it is our business to operate? If so, then to all institutions of higher learning there comes a new and most important challenge to give out of their intellectual resources, to grown men and women busy in life, those things that can be immediately translated to life and labor and applied at once to the solution of contemporary problems.

With fatuous habitude of mind we have been assuming what has been accepted for many generations, that if we train the child during infancy and youth we thereby determine his course of life. Have we not learned that that thought process needs revision? The really effective and important part of the lives of men and women has always been and must always be cast in the adult period. Why not recognize in fact that which we must admit in theory, that youth education is after all, chiefly training in how to live and learn?

Fourth, I have hinted above at our increased leisure opportunities. People generally have more leisure than they ever enjoyed before. Hundreds, yes thousands of intelligent folk have more urgent need of knowing what to do with unoccupied time than for any other advantage. The one effective time-filler is a full and active mind. My own observation convinces me that here is a mass of latent civic and social energy that needs only the touch and guidance of a strong, wisely-conceived educational agency to make it dynamic. Here is a splendid opportunity for adult education.

Of course, much depends on the manner and point of view in which institutions of higher learning meet this opportunity or obligation. What they can do in this field must of necessity be extra-mural education. Extra-mural functions of colleges or universities are expressed through varied avenues and lanes of approach. Some are formal, others informal. Most of them are as yet as imperfectly developed as they are variously undertaken.

For one thing, there is the problem of academic preparation. As I see it, adult education must accept men and women as they are. Of course, they cannot master a technical subject to which some other course or topic is prerequisite without having covered the prerequisite field. Also, because people are so various and adults are independent, some grown-ups will respond in one way and some in others to the offerings of the college. In adult education the relations between the teacher and learner must be of the partnership type and not approached from the auth-

oritarian angle, which now so widely prevails. We may expect that many adults carrying on continued educational adventures or interests may surpass their teachers in maturity, experience, and even in common knowledge in other fields than the one under immediate consideration· However, if the right spirit prevails, the one under immediate consideration. nize necessary partnership relation, the result for each will be increased satisfaction and benefit. To my way of thinking, for this relationship to be established and recognized will be a great gain to the teacher. Also, it will make it easy for adults to remain progressively intelligent and open-minded with respect to the progress of others around them. Instead of individuals being influenced by the bias of propaganda, in the minds of both teacher and learner authentic facts would discriminate, and justice and understanding would prevail.

Another interesting point projects itself into the subject here. There is a widespread feeling that education has in some respects, perhaps in many, lost its way. We need not look very far to discern a tremendous amount of groping and grasping among people responsible for directing education. This, it seems to me, is the result of the fatuous attempt to educate people *en masse*. Colleges and high schools, originally conceived and built for the more or less individual instruction of a chosen few, are inundated with waves on waves of presumably qualified applicants for admission. They have more folks than they can serve well. Every year they grind out huge grists of heterogeneous products.

Education is an absolutely individual process. It never was and never can be anything else. We can perhaps teach people facts in the mass, but educating them is done one person at a time. Now adult education seems to me to offer a rare opportunity to individualize instruction. Grown folks who know how to learn, studying either by themselves under correspondence direction, or with equal individualness when assembled in classes, or under the most informal or general direction, can work as individuals.

If this adult education movement accepts its challenge, and functions as I believe it can, it may help all education to find its way and contribute much to educational procedure and results in every area. Naturally, this means new demands upon leadership, but it cannot only greatly influence the building of the generation that now is; it can fortify the larger and wiser one we hope is coming. One cannot reflect upon the issues of adult education without being stimulated by its possibilities. Here we have in America, in heterogeneous grouping, the contributions of the best of all the racial and national elements. The mingling of blood and the crossing of purposes will achieve some remarkable results. I believe is is reasonable to hope that the light of scholarship cast upon every form of social leading will help us to avoid many mistakes that would set us back, and will enable us to build rationally and constructively. Our vast population is one. It is not cut by any natural barriers such as those that have divided Europe. In our vast area has arisen wonderful commonwealth institutions of higher learning. In our wide areas we have the greatest runway in the world, both for the winds and for the ideas of men. The very nature of our country begets at least an insurgent spirit. That insurgent spirit must ever be kept intelligent and creative for the achievement of a purpose. A stimulation of the educative processes in the minds of grown men and women seems to me to offer an undeniable contribution.

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Some Problems in the Training of Geography Teachers

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The relatively long period of time which elapses between the study of formal geography in the eighth grade and the fresh contact with geographic subject matter in methods courses in the Normal School presents a weakness which is quickly revealed to the teacher of geography methods. The problem is by no means limited to this particular subject, but is one which confronts the general methods teacher, the supervisor of student teaching, and the teacher of special methods of practically every elementary school subject. When confronted with the evidence of their lack of knowledge in the elementary subject, Normal School students often complain that it has been so long since they studied the subject, they have had little call for many of the facts in their high school courses, that it is no wonder they do not know them. The theorizing as to an interest in world affaffairs, the reading of newspapers and the magazines, the correlative functioning of eighth grade subjects in high school courses as sufficient factors in keeping geography fresh in mind does not remedy the condition as it is found among incoming Freshmen at the Normal school.

Many a would-be teacher is able to pass a fact test in geography without understanding any of the principles involved, and can accordingly do little but teach the children the elemental facts or as often happens "imagined facts." You are sufficiently familiar with the discussion of the falsity of many of our popular concepts concerning physical geography, industrial geography, or statements as to beliefs and customs of other peoples or the habits of animals common to various regions of the earth.

I shall indicate briefly but one or two instances to illustrate the lack of preparation of would-be-teachers.

Forty-six students in a beginning geography methods class were asked to write briefly on the following question: "Which is higher, Lake Erie or Lake Ontario? Give reasons for your answer." Twenty-eight answered "Lake Erie," while the other eighteen stated that Lake Ontario is higher than Lake Erie. Of the twenty-eight, five gave no reason at all, merely stating that Lake Erie is higher than Lake Ontario; twenty-one gave rather simple rote statements in terms of falls, direction of flow of water, drainage and so forth. Four of these gave as part or all of their explanations, the interpretation of the colors of the map; for instance "Erie is higher because there is less green around it. Green represents the lowlands," and "Lake Erie is the higher judging from the altitude as shown by the color of the map of the surrounding country." Only two gave what might be called fairly well developed answers.

Of the eighteen who named Lake Ontario as the higher, five merely stated this as a fact. Of the remaining thirteen, the answers of five indicate that they thought only of the relative position of the lakes on the map, "higher" meaning for them "further North" or "higher on the map." Two of the answers are: "Ontario higher, it extends to about 44 degrees above equator while Erie is about 42 degrees;" "Ontario is higher because it is north of Buffalo, and Lake Erie is to the south or below Buffalo." Three mentioned Niagara Falls as an indicator of relative altitude; three said that Ontario drained into Erie; one that "Lake

Erie is located more in a valley"; and the other that rougher country around Lake Ontario showed it to be the higher.

A very tempting explanation of the failure of several of the students would be on the basis of the scores they made on the Army Alpha Intelligence Test or the Thorndike Intelligence Examination, both of which have been used at the Normal; but an examination of the ratings of the entire group gives the following distribution of alpha ratings. The first group, 14 A's, 12 B's, 2 C's; second group 7 A's, 8 B's, 3 C's. Nor would there be any explanation here for the flat failure of some of the students with high A rating.

The coefficient of correlation between scores on the Gregory-Spencer Geography test and the Army Alpha for 226 cases tested in September 1922 is $+0.416 \pm .037$. The correlation between geography tests and scores on the first part of the Thorndike Examination has varied with the groups: Jan. 1924, for 134 cases $r = 0.293 \pm .053$, June 1924, for 180 cases, a fair percentage of whom were experienced teachers, $r = 0.337 \pm .044$. The correlation was much higher in October of 1924, being $+ 0.563 \pm .029$. There seemed to be more differentiation in the testing of this group also—all with I. Q's. less than 95 failed on the geography test: but this number was only seven. It fails to throw any light on the failure of bright students.

A variation of the question about Lake Erie and Lake Ontario was given a year later. The Freshmen were confronted with a sketch showing Lakes Erie and Ontario, the St. Lawrence river and the Gulf of St. Lawrence. They were asked this question: "Which has the greater altitude Lake Erie or Lake Ontario? How do you know?" Even on this a large number failed.

A number of exercises have been assigned to test their ability to image the various processes discussed in geography. For instance, "State the precise images that come to your mind when you say coal furnished power in factories. Do not answer manufacturing or turning wheels, etc., but the precise thing you see the machine doing. *Use illustrations that would suggest power to a child.*"

The following answers selected at random indicate what sort of a problem the teacher of geography methods faces.

1. "Coal is power in manufacturing. Used to turn water to steam as a means of power of *machinery for manufacture.* (ex.—Engines, wheels, etc. Smelting purposes prepares the iron for use as machinery."

2. "Furnishes power to run machinery. It heats the iron or melts it, and furnishes this power in the machinery to shape and mould the iron. The same in a glass factory or automobile factory."

3. "Coal heats houses and stores. It is used for the smelting of iron. Also used in the place of water power. It is necessary in transportation."

4 "Coal produces power for grinding wheat into flour in the mills. For smelting iron, for heating water and causing steam for running the machinery in a boat; forms steam to run the crushing machinery in a sugar factory (for crushing sugar cane.) Runs the machines for cutting sole leather in a shoe factory."

"It is used to form steam to run the machinery in a metal factory and helps to shape teapots, perculators, etc.

"Coal is also used for heating purposes in the furnaces of buildings and to heat water for many purposes."

5. "Coal is used in manufacturing plants. If one went into an automobile factory, huge belts or wheels would be turning but behind these, the coal would be furnishing the force to make the wheels turn. Then these wheels would smooth down the steel and iron converting them into automobile wheels. Another scene might be a shoe factory, im-

mense furnace heated thru coal would cause power to turn belts; to weave down the leather and force it into shape. Forms steam to carry products out."

6. "I can see coal creating power which sews soles to upper leather of shoes, moving shuttle in weaving of cloth, engraving designs in silver plates."

7. "The coal is burned and the heat travels thru pipes to parts of factory. At different sections there are small pistons which are forced back and forth by the heat. In so doing, the machinery operates each piece dependent upon the other. The machinery operates and is thus used for manufacturing. Heats factory. I can see it melting things."

8. "Coal produces power for heating metals for tempering and shaping. Coal produces great heat and thus a gas that is of commercial value and charcoal. Coal heats glass for producing new shapes. Coal turns machinery that produces great pressure on metals and compresses paper, cotton, rubber, etc. Coal produces heat and steam that runs our powerful railroad engines, our steam buckets, conveyors and excavators. It runs our ocean-going boats. Coal heats iron ore and makes pig iron. Coal heat produces our finest steel."

9. "Coal is used as power in a flour mill. It makes the power which runs the machinery. The machinery separates the poor and good grains. The machinery grinds the wheat into flour. Great sifters run by coal power sift the different grades of flour."

A study of the results of tests in the other elementary school subjects reveals the same kind of conditions.

In order to secure teachers that know the subject matter one of two things seems necessary. Either the Normal School must take time to teach them the elementary subjects which is not their function, and which would be a great waste of time and money, or definite entrance requirements must be established which would throw the responsibility back on the lower schools.

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Cholecystography

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Cholecystography is a method of radiographing the gallbladder after filling with a phenolphthalein dye which is given to the patient intravenously or orally. The diagnostic value of this method places it as the most outstanding development in the radiographic field in the past four or five years. Graham, Cole and Gopher of the Department of Radiology and Surgery, Washington University School of Medicine and Barnes Hospital at St. Louis, gave their preliminary report on the discovery and development of cholecystography in February, 1924.

Cholecystography is made possible by the excretion or secretion by the liver of the halogen compounds of the phenolphthalein, the so-called "dyes." The drug first recommended by Graham, Cole and Gopher was sodium tetrabromphenolphthalein. This was used intravenously.

After using the bromine drug and getting very severe reaction and shock, Whittaker of Peter Bent Brigham Hospital began the use of sodium tetraiodophenolphthalein orally and intravenously without severe reactions. He found this drug better and less toxic than the bromine drug. The reason for this is that it can be given in smaller doses, one-half of the amount required of the bromine drug being sufficient.

Investigation of other substances is in progress and some more desirable compound may be found. Drake of the Research Department of the Mallinckrodt Chemical Works, St. Louis, has prepared a large number of substances, many of which have been tried out, and ten of which have the power of making the gallbladder visible. So far, the sodium tetraiodophenolphthalein has proven to be superior to any of the others.

Several methods of administering the drug have been tried. The two methods most generally used are the oral and the intravenous. The oral method was made possible by the discovery of a compound that can be used orally. This method is much easier to use than the intravenous, there is less reaction, and it can be easily repeated. It may cause some nausea, vomiting and diarrhea, but nothing that is serious. It can more conveniently be used as an office procedure. The resulting gallbladder shadows are practically identical with both methods, with a little in favor of the intravenous. Some laboratories use one method and some the other. Opinion seems to be divided.

Whittaker found the intravenous method to give severe reaction with nausea, vomiting and headache in 8 per cent of 60 cases. Thirteen cases of no shadow by oral method were given the drug intravenously and in eleven of these the findings were confirmed. Whittaker himself had the intravenous method with the bromine drug, later with the iodine drug and also the oral administration of the iodine drug; and he says, personally he prefers the iodine drug, oral method.

Now we will describe the process of cholecystography. The dye is introduced into the system by one method or the other and should reach the liver in a certian time, which time varies according to the method used. In using the oral method, if the capsules are retained one hour, enough dye will go through to give a satisfactory shadow. It takes about twelve hours for the dye to reach the region of the hepatic flexure and presence of the drug in that region on a film is a reliable index. If there is no dye in this region, we need not be surprised if none has reached the liver. We found, however, that even cases that have had vomiting

or diarrhea usually have enough dye to give satisfactory results.

The substance reaches the liver and is excreted, and is concentrated in the gall bladder. Naturally no shadow appears, if the liver is unable to excrete the dye in sufficient quantities, if the duct is occluded or if the function of the gall bladder in concentrating is impaired.

It has been found that the gall bladder empties during digestion. Films taken after the patient has eaten will show a gall bladder much smaller in size, about 50 per cent of that on first films, or no shadow. If the gall bladder shadow is of standard density, regular in outline, homogeneous, and decreases in size after the patient eats fat or protein food, we may call it a normal gall bladder. The emptying time varies within certain normal limits and according to the method used.

The pathological gall bladder does not fill or does not fill completely. The density may be reduced because of inability to concentrate. The outline may be irregular and abnormal; the size may be increased. It is always necessary to be sure there is enough dye in the region of the hepatic flexure to give a test.

One of the interesting discoveries due to cholecystography is the unexpected positions of the gall bladder in different people. We have found that the position varies and others report the same thing. We find it anywhere in the right side of abdomen, sometimes even below the crest of the ilium. To know the position of the gall bladder is a distinct aid in differential diagnosis.

Thus cholecystography has become a safe clinical procedure of unquestioned effectiveness in the diagnosis of abnormalities of the biliary tract, even in such mild cases of cholecystitis that an accurate diagnosis by other means would be impossible. Its value is not only in ability to recognize gross pathology of the biliary tract but also in the fact that it serves as a functional test as I have explained above.

Our routine for the use of the sodium tetraiodophenolphthalein orally is as follows. The patient takes the capsules the evening before the X-rays are to be taken. Twelve hours later he reports for the first series of films; again at fourteen hours; then he eats some fat or protein food and returns two and a half hours later.

In concluding, we wish to emphasize that cholecystography is a definite standardized procedure to aid in determining pathologic and functional abnormalities of the gall bladder. A study of the radiographs shows definite conditions and correct interpretation requires experience and judgment which comes from the study of a large number of cholecystograms.

Mistakes in diagnosis are not due to the method but to wrong interpretations.

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The Accessory Sinuses of the Nose

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Within the past few years the term "sinusitis" has become so common that one rarely fails to hear of some friend who has not been afflicted with this condition. In fact, Irvin Cobb, who some time ago wrote "Speaking of Operations" might well now add to literary achievements by publishing another volume, the title to read "Speaking of Sinuses."

What are these sinuses that we hear so much about, and what is meant by sinusitis? The sinuses are bony cavities situated in the head which have a direct communication with the nose and with each other. There are four pairs of sinuses: (1) Maxillary, (2) Frontal, (3) Ethmoid, and (4) Sphenoid. For the purpose of orientation these may be described.

The largest and lowest of these is the antrum or maxillary sinus which lies in the maxillary or upper jaw bone between the roof of the mouth and the bony socket containing the eye. At birth the antrum is not present, but at the age of three there is formed in this region a small cavity the size of a pea. This gradually increases in size until at fifteen it resembles that of a pigeon's egg. The mucous membrane lining the nose and throat is continuous with that of the antrum as well as the other accessory sinuses. Different theories have been advanced as to the real purpose of nature providing us with these bony cavities. Among these are that they serve to lighten the bones of the skull, and that they aid in breathing. Also, that the resonance or quality of one's voice is directly determined by the condition of the sinuses.

The frontal sinus is a much smaller structure, and lies between the area containing the eye and the upper nasal passage. The ethmoids have an arrangement similar to a honey-comb, containing from eight to ten small bony cavities each separated from its fellow by a very thin plate of bone, the walls of which are lined with mucuous membrane. These cells communicate in front with the frontal sinus, below with the antrum, and behind with the sphenoid which is usually designated as the last ethmoid cell. This is a fairly large cell about the size of a marble. Therefore, when one sinus is involved the others are also, although to a lesser degree.

When I tell you that the frontal, ethmoid and sphenoid sinuses are separated from the brain by a comparative thin sheet of bone and that the optic nerve, the nerve of sight, is not infrequently affected by disease of these sinuses, the importance of a thorough examination and early treatment cannot be taken lightly.

The bacteria commonly found in sinus infections are the Pneumococcus which causes pneumonia, the influenza bacillus, and certain low grade microorganisms called Staphylococci.

Before proceeding with a definite outline of the mode in which sinus infection originates it will be necessary to mention certain structures found in the nose, because an abnormality of these is in the vast majority of cases the real underlying cause for disease of these sinuses.

In the first place, the nose is a triangular shaped organ, the apex of this being formed from above downward by the nasal bone, the perpendicular plate of the ethmoid, and the dependent part by cartilage. It is this cartilaginous and bony framework which divides the nose into two similar compartments by means of which the air is enabled to reach the lungs by first being carried through the nose to

the throat, and thence by the trachea to the lungs.

On the sides or lateral wall of the nose are three bony ridges lined by a delicate mucous membrane, and to them has been given the name turbinates, or turbinate bodies. Because of the position which they occupy in the nose, they have been designated the (1) Superior, or upper, (2) the Middle, and (3) the Inferior, or lower, turbinates.

We are now in a position to present certain features of sinus trouble which may be familiar to some of you through experience. Suppose on waking in the morning, and hurrying through your breakfast, you glance out the window, decide it is a warm day and that you won't wear your heavy coat; or, it may be raining and you say to yourself, "Well, I have a good storm coat. What do I want to wear rubbers or carry an umbrella for?" And in that frame of mind you proceed to your place of business. In fifty percent of the cases nothing happens,—the other fifty percent is a different story. Perhaps by the middle of the day, you feel a tingling in your nose, your eyes begin to water, you sneeze, and soon your voice sounds like a stranger's. You say, "Well, I guess I've a cold in my head—I should worry, that's nothing." For a moment, let us see what has taken place in the nose. When one's resistance is low, these bacteria that I have mentioned gain a foothold on this delicate membrane lining the nose and within a short time this swells so that a membrane whose normal thickness is about one millimeter may increase to ten millimeters. The turbinates also become swollen, and as a result the ability of the nose to function is restricted. This tendency to obstruction may be increased by polyps—structures which are pale glistening bodies which hang down in the nasal cavity from their attachment to the space between the middle and inferior turbinate bones, called the middle meatus. Or what is even more common, through an accidental blow to the nose the cartilaginous partition between the nostrils becomes bent toward one side impairing the ability of that side of the nose to function. With the added obstruction caused by the swelling of the nose, there may be a complete block to air entering the affected nostril. If you will now recall that I stated that each sinus communicates with the nose, it can be seen how an infection in the nose may travel to any of the sinuses. When this takes place, one has a beginning sinus infection. If treatment be instituted early to cause shrinkage of the nose and allow the sinus to drain, recovery will be prompt. However, this often cannot be accomplished because of an abnormal arrangement of the individual nose, such as deflected septum or spurs of bones, enlarged turbinates, etc. During the acute stage, the chief symptoms noted are a watery or yellowish green discharge from the nose or a dripping of such secretion into the throat, a sense of fullness in one or both nostrils, and headache made worse by change of position.

Following this acute stage, the membrane lining the affected sinus which has been inflamed and covered with a watery secretion now becomes thickened with a yellowish or greenish layer containing bacteria, and leucocytes of the blood which find their way to the infected point in an attempt to overcome the infection. After four to six weeks a sinus infection becomes chronic, and with this the various rheumatic pains, neuralgias, headache, and persistent discharge from the nose and throat take place.

With this thickening of the membrane, the size of the cavity becomes much smaller and as a result the normal drainage passage becomes so compressed that the secretion becomes stagnant, and as a result an intense headache is producd.

It is usually at this period when we see the neglected cases, and as a rule operative treatment is necessary for relief.

I now wish to discuss briefly a phase of sinus infection with regard to swimming. There is no particular climate where one may be reasonably free from this condition unless it be in Arizona or parts of Texas. Sinusitis is just as prevalent along the Pacific coast as it is along the Atlantic seaboard or the Great Lakes region or our inland lakes. Science has been unable to prove that man was ever designed to be an aquatic animal. In fact, the ears and nose of man are so constructed as to invite rather than repulse the inflow of water especially in diving. It is common knowledge that many professional swimmers have ruptured or perforated ear drums, and that many of the deaths attributed to cramps while in the water are due to a disturbance of the equilibrium center in the brain due to water entering the inner ear through the perforated drum and thereby resulting in a labrynthitis, or in plain words one's sense of direction becomes lost due to this irritation, and instead of raising to the surface, he dives toward the bottom, becomes frightened, swallows water which enters the lungs and he is drowned.

Let us now consider the swimming pool. The usual practise is for the swimmer to be requested to take a thorough soap and shower bath before entering the tank which is to be commended, but does it go far enough? I will try to point out that it does not. Let us take the average individual, who lightly approaches the spring board, balances for a moment and then executes a dive. On rising he endeavors to rid his nasal passages thoroughly of the water which has entered his nose or throat by coughing, spitting or blowing his nose. Not having a handkerchief for receiving these discharges, they become a part of the pool. Suppose he has a sinus infection. The next individual to enter the tank, though free from nasal infection, has invited infection to himself. It is at this point that bacteria are swept through the nostrils and past the opening to the Eustachian tube which is the connecting point with the throat and the middle ear. If bacteria enter this tube by means of the contaminated water, then a process is set up within the middle ear (that portion behind the drum) similar to that present in the nose with sinus infection, and there results a feeling of fullness or stuffiness in the ear with pain, the so-called earache. The drum on examination now appears red, and bulges forward and demands incision for relief of pain. This in the vast majority of cases will clear up the infection. However, the process may have spread by means of a small bony channel, called the antrum, to a honeycombed structure behind the ear, known as the mastoid. Certain types of bacteria are very destructive to bone, and so it is that these bone cells of the mastoid which have a honey-combed appearance become destroyed with pus formation and we now have a condition of mastoiditis—a serious condition demanding treatment by a skilled otologist because the brain is separated from the mastoid process by a very thin plate of bone, and the large veins from the brain take a course to the outer side of this mastoid process to enter the neck. The complications arising from an attack of mastoiditis are always a source of worry to those who constantly see these cases, and if any of those present did not appreciate the significance of an infection through accessory sinuses before, I hope they do now.

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The Science and Application of City Planning

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City planning is often spoken of as something new or recently discovered in the arrangements of cities, yet as far back as we read of the building of cities we find occasional allusion to an effort on the part of those who built them to have some plan toward which to build.

To be sure, there are many examples of the thing which should not be done but at least there are some examples of an effort on the part of the builder to use in some fashion a measure of the reasoning that we now apply and call City Planning.

In that period of the world's history, however, the minds of the educated people of the world turned to the accomplishments in art and literature and the great sculptural and architectural monuments that were produced in those times were the reflection of the thought of the people of the time, so, whatever planning was done was with the single purpose in view of setting forth to the best advantage the monument, the piece of sculpture or the work of art, rather than any broad conception of a general plan for improving the sanitary condition of the country, the avenues of business or the living conditions of the common people.

In the past few years, however, we have come to apply a different unit of measure of things in general than was the case in medieval times. Where the object then was largely sentimental in the display of art, architecture and literature, we now apply the scientific measuring stick, and problems after an analytical study are approached from a scientific standpoint; where once the expenditure of public and private funds was for the purpose of exciting wonder and admiration on the part of the people our present tendency is to provide for the convenience, comfort and sanitation of the public.

Like most things which are only imperfectly understood there is often much more expected from City Planning than can actually be accomplished. It is only human nature to be selfish and many have some petty grievance they are anxious to legislate against, and if they can be brought to believe that zoning, for instance, would compel their neighbor to remove his chicken house which is an annoyance to them, they are for City Planning. It may never have occurred to them that their own woodshed is just as objectionable to their neighbor as his chicken yard is to them.

Again we are prone to think that a city well-planned should meet the demands of a future civilization without any further changes whatever and are apt to think of any modification that is found necessary to be the result of some gross mistake rather than a change which is normally brought about by the inevitable change in conditions.

We are accustomed every day to seeing people in private life make alterations due to the changing of conditions of the times. For instance, we build a house—it becomes out of date in thirty years and loses its value because people wish to live in a more modern home, consequently we suffer considerable loss in depreciation or we spend considerable money in remodeling the house to meet the demands of modern opinions. This is not a mistake in plan but a necessary result of progress.

Let us now consider what effect this condition has on a city. We may logically assume that where this house previously cited was built there was a whole section of the city built up with houses of the same type which at that time comprised

the most modern and fashionable part of the city, but now thirty years later, by reason of the houses being out of date in this section there is another part of town that is built up with the houses of modern type of architecture and arranged with all the modern conveniences and so we find the former section gradually falling into disfavor, the houses being neglected and the entire district taking on an untidy appearance.

Some city planning enthusiasts would lead us to believe that by proper planning these things could all be avoided, but cities like houses will progress and that which meets the needs of today will be entirely inadequate thirty years hence. This is not to say that a determined effort based upon the most scientific studies should not be made to provide in a comprehensive way for the future needs of the city but we should not allow ourselves to be lead to expect the impossible for it is not given to any human being to look accurately into the future and to tell what the future will bring forth. Who for instance could thirty years ago have foreseen what a change in conditions the automobile has brought about.

When the question of making an effort to acquire the Northwest territory consisting of Washington, Oregon, Idaho and part of Montana as an annexation to the United States was before Congress, it was difficult to secure support for the measure because of the argument that this country was so far away and so infested with savages that it could not be of any use and even if it should be annexed the distance was so great that in case the President summoned Congress to convene there would not be time enough for word of the summons to be sent and the Representative from the district returned so as to get to Washington before Congress would have met and adjourned. This was only a little over one hundred years ago and those were the intelligent citizens of our Nation. We now laugh at their lack of foresight but must remember that those, one hundred years hence, will laugh at us.

Streets designed forty years ago for horse drawn vehicles are not suitable for present traffic and we must change them accordingly. Sewers and water mains to serve only a few acres of built up areas have gradually been overcharged until they are inadequate and must be rebuilt. These are matters incident to the growth of any community and it is not a lack of planning or foresight. Even if you were able to predict accurately forty years ahead it would be impossible to avoid all changes because the small town needs a sewer or water main now and is not able to build one big enough for forty years hence and at the end of forty years the large city is better able to stand the additional expense than the smaller city of forty years ago was able to build them large enough to provide for the future growth.

We remodel our houses every eight or ten years to introduce modern conveniences; we trade in our automobiles every few years to keep up to date and remodel our radios almost daily, not because we made a mistake in the first instance but because none of us are able to forsee what the future will bring forth. Likewise in the growth of our cities we must expect a certain amount of change as our cities develop and no planning regardless of how carefully done will prevent it altogether.

I do not wish to be understood as arguing against an intelligent study into the needs of every city. On the contrary I believe great good can be accomplished in this way through the planning of every city, but this can only be done after we have a correct understanding of the limitations as well as the benefits to come from such studies. I firmly believe that more harm has been done to the city planning movement by the ardent enthusiasts who make extra-

vagant and unwarranted claims for what city planning will do than through any other source.

Now that we have considered hastily and briefly what city planning cannot do and should not be expected to do, let us turn our attention to what city planning really is and what benefits we may reasonably expect to result from a systematic and scientific study of city problems.

Cities like individuals have their personal characteristics and the practice of one city being planned in accordance to some other city which is held up as an ideal of perfection is sure to bring disaster. Inasmuch as the only justification for a plan at all is that it serves the people living in the community, every effort should be made to get the matter before the public and work with, rather than against public opinion when such opinion comes after a thorough knowledge of the subject.

The idea seems to be quite prevalent that city planning for any particular town is something that may be taken up whenever sufficient popular interest has been aroused and pursued with enthusiasm until with the aid of special expert advice a definite plan shall have been evolved which will probably necessitate considerable rearrangement and that the town will then have been started on the right road for its future development.

A good city plan for a well established town that wants to correct some of its old defects and properly control its future growth has rarely, if ever, been produced as a sudden inspiration nor has it been the result of a few weeks or months of study by a man or a group of men unfamiliar with the traditions, the habits and the peculiar needs of the people and yet that is the usual procedure.

Commissions have been created, experts have been retained and acres of plans in the form of cleverly drawn maps and pictures have been produced but little lasting benefit has resulted. The creation of a proper plan will require years of patient study and the men who do it will be forgotten before it is carried out. It is no one man job, nor is it ever actually finished. However carefully and skillfully the first plan may have been made, unforseen changes will take place, new methods of transportation will develop, new inventions will powerfully affect the social life of the community and the plans where still susceptible of change must be modified to meet these changed conditions.

The greatest care must be used to make sure that whatever plans is made or whatever ordinance enforced must serve the interest of the community at large rather than some organized minority who constantly make themselves heard.

Every one living in the city and those who come from elsewhere are either convenienced by the systematic and intelligent arrangement of the traffic ways or they are inconvienced by their lack of system and good arrangement. The roadway, that is the space between curbs, is only good for one thing and that is to sustain the traffic that comes to this particular street, both through traffic and local and should be only of sufficient width to serve this purpose adequately, as extremely wide roadways as an ornament are far too expensive an ornamentation. It costs a great deal of money to keep such dirt streets shaped up and cared for and when the time comes for them to be paved it is often prohibitive in cost, hence those roadways which are made wider than necessary for the accommodation of traffic are a menace rather than a benefit. Likewise many are narrow where they should be wide which leads to traffic congestion and delay. These matters which in the past were largely a matter of sentiment or preference, are, when approached from the viewpoint of the city planner, a matter of scientific determination and streets are

laid out according to what facts would justify.

Sanitation is a matter of primary importance to every community and goes far beyond the mere matter of constructing the necessary sewers, which is usually worked out from an engineering standpoint and reasonably keeps pace with the development of the city and demands of the public, but the problem of providing the future requirement for light and air is a matter that is often overlooked entirely until too late to remedy. Every city is therefore entitled to exact regulations which prevent the man who builds an apartment house from occupying the full size of the lot with his building thus making it necessary for the neighboring lot owner to leave all the open space for this purpose between buildings on his own lot hence taking away property to which he is rightfully entitled or permitting him to commit the same offence against the public that the former builder has committed by building squarely up to the line thus depriving those who occupy both buildings from the sunlight and fresh air which is the rightful heritage of every person whether rich or poor and without which we cannot remain good healthy normal citizens, a thing with which the community at large is greatly concerned.

The bombastic character of the city planning movement which swept over our country like an epidemic several years ago will be lacking in the city planning of the future. It will take on a sane progressive scientific study into the problems of our cities and in place of the confusion which has accompanied the adoption of ordinances pertaining to city planning in the past, these changes will be brought about along with the development of the city in such a gradual manner as to cause little or no comment.

As pointed out in the opening paragraphs of this paper there is nothing new in city planning; it is merely the application of science to the problems which are as old as civilization itself, those incident to the growth of our cities and whereas in the past these problems if recognized at all were either dealt with as a matter of sentiment or political expedience we now approach them from a scientific standpoint as we do countless other problems of to-day.

It is obvious that in a paper of this length it is impossible to even outline in the briefest fashion a subject so broad as that of city planning, a subject upon which volumes have been written. It is sufficient to say that the trend of modern city planning is headed in the proper direction when problems incident to a city's growth will be solved by science rather than by sentiment.

Office of City Engineer,
Spokane, Wash.

Water Resourses of the Pacific Northwest

GLENN L. PARKER

THE SERVICE OF SCIENCE

The Pacific Northwest is the last great frontier of the United States proper. It was settled and has been developed largely by frontiersmen, who have toiled wearily, have withstood the most severe hardships, and by virtue of indomitable energy and resourcefulness have subdued the wilderness. The period of pioneering is almost past. The strength, brawn, and endurance of yesterday will still be needed tomorrow but its effectiveness will be greater and its accomplishment more enduring and satisfying on account of activities of such organizations as yours in gathering basic facts, studying natural phenomena, and developing theories. The application of the fundamental information so gained, to practical use is a high calling and presents almost unlimited opportunities for constructive service to society. The Pacific Northwest needs scientific research. Its natural resources, though tremendous, are not altogether inexhaustible; wise and efficient use of them is imperative, not only for the region, but also for the country as a whole.

COMPARISON OF NATURAL RESOURCES

Most of our natural resources lack permanence. When coal and minerals are mined the supply is depleted. When the forest areas are logged off, new forests grow and mature slowly. Constant cropping of the soil deprives it of those substances necessary for plant growth so that fertilizers of various kinds must be used. Our fishing industry is waning in spite of vigorous efforts put forth by federal and state agencies. Water resources are unlike all of these in that they are constantly renewed. Beneficial use of water does not prevent its replenishment. It is true that, during geologic units of time, water supply fluctuates greatly. Bretz (1) has gathered information which seems to indicate that the flow of the Columbia River was over 66,000,000 second-feet some time after the glaciers began to recede, whereas the maximum known flow during present times is only 1,170,000 second-feet and the average flow is only 210,000 second-feet. Considerable evidence is available to indicate that the water supply of continents has fluctuated widely during historic times and that these fluctuations have probably been synchronous throughout the world. The amplitude of such changes in water supply, however, is much less than that which occurs between periods of glacial accummulation. Also the time interval of the cycle is much shorter, but even so it extends over a period of perhaps 1,500 years. The so-called Bruckner climatic cycles covering periods of about 36 years have still less amplitude but in some regions they appear to be responsible for a considerable change in water supply. Although water supply is subject to fluctuation, that fluctuation is probably not serious in the Pacific Northwest over periods of several centuries and perhaps even longer stretches of time. Therefore the Northwest's water resources may be considered the most stable and permanent of all natural resources. This permanence of water resources and their great abundance in the Pacific Northwest cause the writer to conclude that ultimately the water resources of the Northwest will prove to be its most valuable asset.

THE FUTURE

Little vision is needed to foresee the time when the Pacific Northwest will be

1. Bretz, J. H. The Spokane Flood beyond the Channelled Scablands. Jour. Geol. 33: 236-259. 1925.

a great industrial, agricultural and mining region. These three great activities are mutually dependent upon each other. Industry uses large quantities of metals and to be prosperous must have a substantial agricultural background in order that food may be available at reasonable prices. Agriculture requires manufactured articles and the products of mines. It needs a nearby market for commodities. One of the difficulties being experienced by local farmers now is the high cost of shipping commodities long distances to remote markets. A close, compact market would be extremely helpful. Likewise mining must depend to a considerable extent on industry and agriculture for absorbing its output. This inter-relation of interests is becoming recognized so that greater team work may be expected in the future than has been experienced in the past. Some favorable conditions for rapid expansion of these great activities are as follows:

1. An abundance of water and other raw materials.

2. An almost unlimited amount of cheap water power possibilities concentrated within a relatively small area.

3. An equable, healthful climate with sufficient seasonal change to be invigorating and energizing. Huntington (1) has made an exhaustive study of the effect of climate on civilization. He gives the Pacific Northwest a high rank in those climatic factors which are most favorable for human accomplishment.

4. Excellent harbors, and what is more important deep and spacious harbors,

5. Proximity to Oriental markets. The Pacific Coast is nearly 5,000 miles nearer Hong Kong and other Oriental ports than is Liverpool via the Suez Canal. In terms of steamer time the Pacific Northwest ports average slightly over a day nearer Yokohama, Shanghai, and Hong Kong than Los Angeles. If each Oriental sought to buy an apple a year, many would have to wait for new orchards to grow. If each one should order a pair of shoes the shoe industry would be swamped for years, and shoe factories would soon be located in the Pacific Northwest. More apples will be grown and sooner or later shoe factories, together with other manufacturing activities, will come to the Northwest. The Standard Oil Company created a substantial demand in the Orient for kerosene. Other demands will be created and still others will materialize as modernization proceeds.

1. Huntington, Ellsworth. Civilization and Climate, pp. 130 and 134.

IRRIGATION

The irrigable area in the Pacific Northwest embraces about eight and one-fourth million areas, of which nearly five million acres are located in the Snake River drainage. Only about 3,800,000 acres are irrigated now and a somewhat smaller acreage is fully productive so that considerably less than half of the agricultural possibilities of the Northwest are developed.

Thickly settled industrial and mining centers would not only bring about greater returns to present irrigation but would hasten the day when full agricultural development could be made profitable. The Department of Commerce estimates that the normal growth in population of the United States, within the next 25 or 30 years, will cause more intensive cultivation of present agricultural areas and the utilization of all reclaimable areas. Otherwise America will become a great food importing nation with a resulting decrease in trade balances to be offset by lower standards of living.

The largest irrigation project in the Northwest, and in the United States as well, is located near the center of the Pacific Northwest. The Columbia Basin Project could not be made fully produc-

tive within 25 years if the present Congress should authorize its construction and make the first appropriation. Engineering and economic investigations, covering a period of about three years would be necessary before any contracts could be let. Then a construction program extending over about eight years would be needed to bring water to the first unit, embracing an area of 300,000 to 400,000 acres. Settlement and development of the first unit would require at least five years. Hence production from the first unit could not be a factor in market conditions until about 1944.

Many indications seem to point to an end of the present agricultural depression many years before the first unit could produce crops.

President Coolidge recognizes that the Columbia Basin Project is an important factor in the growth of the Nation. Secretary Hoover has endorsed it. The Senate and the House Committees of Reclamation and Irrigation seem to be favorably impressed with it. The general public, particularly in the Northwest, no longer considers it a pipe dream.

Scientists must have vision and must cultivate imagination to solve their problems, but they may not realize the magnitude of the Columbia Basin Project unless they have given particular attention to the plans for development. Therefore some of the features of the project will be mentioned. The project area, 1,883,000 acres, is almost equal to the combined area of Delaware and Rhode Island. It can be constructed at less cost than six modern battle cruisers and will require only a temporary loan from the Government. The capacity of the main conduit must be somewhat greater than the low water flow of Snake River at its mouth. This conduit will be longer than the air line distance between Tacoma and Portland. Tunnels, 33.4 miles in length, and large enough to be used for a double track railway, will be needed. Directly and indirectly it will increase the population of the Northwest by at least 300,000.

The water is to be diverted from Clark Fork of Columbia River at an elevation of about 2,060 feet, at Albany Falls, in Idaho near the boundary between Washington and Idaho, and about 50 miles northeast of Spokane. The water will be carried through canals, tunnels, artificial and natural lakes for a distance of 135 miles to reach the main body of land which lies in eastern central Washington, below an elevation of 1,700 feet. The water supply is ample but the natural fluctuation of flow does not fit the project requirements so that 2,220,000 acre-feet of storage will be required. Scientists have a duty to perform in explaining the physical and economic features of the Columbia Basin Project to the public.

WATER POWER

Some general statistics are needed to obtain a proper perspective of water power.

Contrary to the common belief the United States is not particularly well endowed with potential water power, although it does lead all other countries in developed water power by a wide margin. According to statistics compiled by the United States Geological Survey (1) it has only 7.7 per cent of the water power of the world, whereas Europe has 12.8 per cent and Asia 15.2 per cent. The country that has the most water power makes the least use of it. Africa has about 42 per cent of the water power of the world, yet in all of Africa less water power is developed than at many of the power plants in the Pacific Northwest. Most of Africa's power is concentrated in the Kongo Basin, in tropical jungles near the equator, where climatic influ-

1. World Atlas of Commercial Geology, Part II, Water Power of the World, 1921; also revised information contained in Department of the Interior press bulletin dated December 19, 1927.

ences are least favorable for human accomplishment according to Ellsworth Huntington.

The water power of the United States is not well distributed. About two thirds of it is located west of the Mississippi River and about one third of it in the three Pacific Northwest states. This concentration in the Pacific Northwest of two and one-half percent of the water power of the world means short transmission distances, and the availability of large blocks of power for industrial enterprise at tidewater. Moreover the concentration is in a climate most favorable to human progress.

Herbert Hoover attributes the industrial predominence of the United States and its high standard of living largely to a greater use of power per capita than any other nation. He believes that maintenance of the present high standard of living is contingent upon the United States continuing its lead in power consumption per capita. Other nations are increasing their power facilities rapidly. Industrialists will doubtless accept the challenge. If so the opportunities of the Northwest will afford them power at as low, if not lower, cost per unit of energy than elsewhere. It should be borne in mind, however, that the cost of power for the average industry is not a very large part of the total cost of production. Proximity to market centers may be more important. Until larger local consumption warrants and until the Oriental market becomes an important factor, perhaps the most attractive field for Northwest power is afforded by electro-chemical and electro-metallurgical processes and pulp and paper enterprises which require large quantities of energy at low unit cost.

The people of the Northwest seem to have little appreciation of these great possibilities. Perhaps it is a case of "familiarity breeds contempt." Why is it that the much discussed and very costly Muscle Shoals development on Tennessee River has received so much public attention? Perhaps it is because Muscle Shoals is appraised by an eastern and southern measuring stick. If a northwestern measuring stick is applied, the Priest Rapids project on Columbia River will be found to be just about twice as powerful as Muscle Shoals yet little is heard of it outside of our own region.

If the Priest Rapids project is developed and the feasibility of creating a market for power in a desert is demonstrated, less difficulties will be encountered in financing other projects on the Columbia River, the lower Snake, and Clark Fork, some of which are larger than the Priest Rapids project. The potential power of the Columbia River, exclusive of tributaries, from the International boundary to tidewater is estimated to be 3,950,000 horsepower, 90 percent of the time, on the basis of natural flow corrected for the effect of future irrigation and navigation. It will exceed 4,800,000 horsepower when upstream regulation for power becomes effective. Estimates at nine dam sites, considered favorable for economical development when market conditions warrant, indicate 2,730,000 horsepower on the basis of natural flow and 3,300,000 horsepower on the basis of regulated flow. Sufficient information is not available for judging the feasibility of development in the remaining stretches.

WATER RESOURCES INVESTIGATIONS

Hydraulic construction work is exceedingly costly. For example, it is conservatively estimated that the cost of fully developing the water resources of the State of Washington will be one and one-fourth billion dollars. How can capital in large amounts be attracted without basic information; particularly the daily records of stream flow covering a long period of years? Most of the physical facts needed

for appraising a hydraulic project can be ascertained within a relatively short time; that is topography, conduit locations, dam sites, cost estimates, and similar information can be obtained within a year or two. The water supply, however, can not be determined within a year or two. A daily record of flow for ten years or more is needed to fit water supply intelligently to the design of project works and to plans for operation.

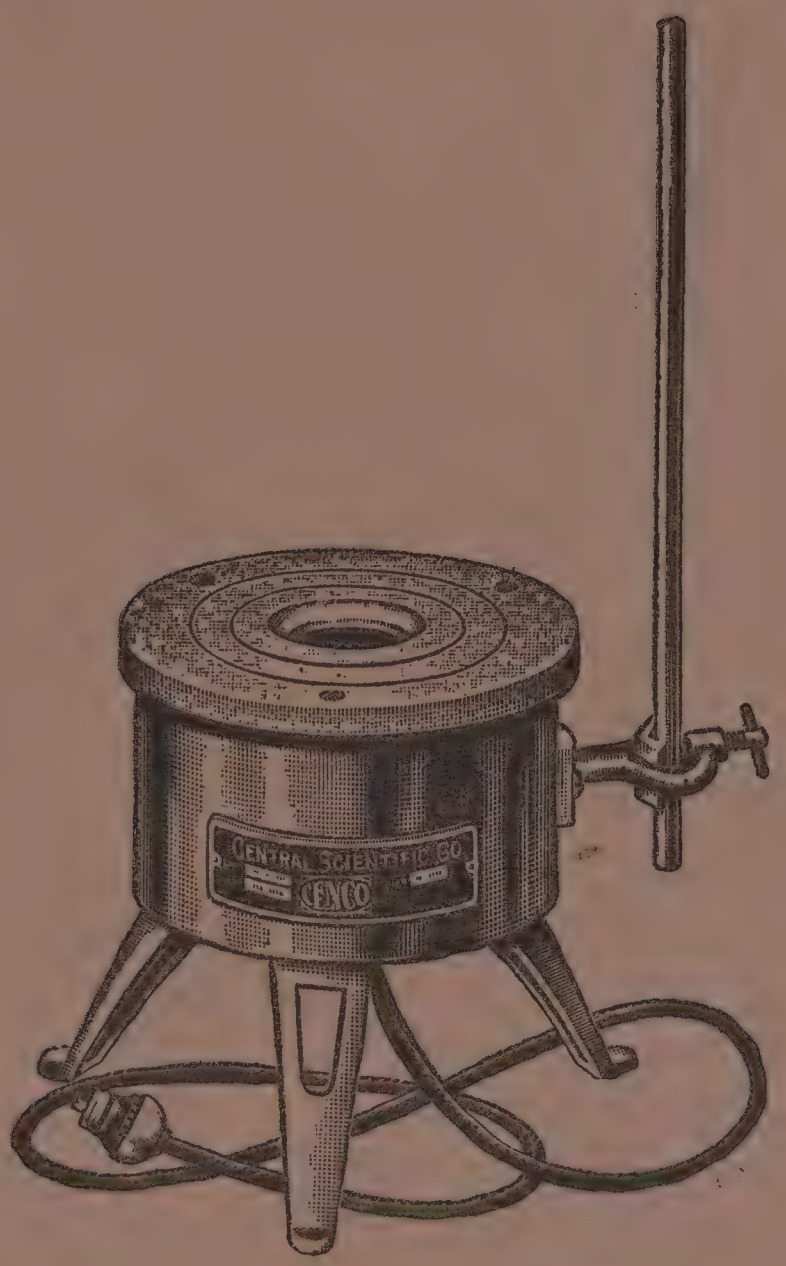
The need for records of stream flow must be anticipated many years in advance of development. Moreover the records should be collected by unbiased, trained specialists so that uniform results, with a high standard of accuracy, will be available for public use. Accordingly the collection of stream flow data is properly the function of the Government. The United States Geological Survey has become the recognized medium of accummulating and publishing daily records of stream flow and other information relating to water resources. Its methods, organization, and personnel have been developed throughout a period of forty years. Great care is exercised in keeping results uniform so that information gathered in one part of the country will be comparable with that collected in another part. The federal appropriations have been so small that most of the states have been cooperating with the Geological Survey, and in addition, municipalities, counties, power companies, and individuals have made substantial contributions in service or funds. Even with such substantial help from many sources, the Geological Survey has not been able to keep abreast with the growing need for stream flow data, brought about by present development. For years it has had no opportunity to anticipate the need for records, even ten years hence. This situation is unfortunate in a region so richly endowed with water-resources. Federal and State expenditures for stream flow records in the Pacific Northwest should be increased four-fold, to permit a coordinated stream gaging program in the several states, designed to yield adequate information for a reliable inventory of water resources.

Office of District Engineer,
U. S. Geological Survey,
Tacoma, Wash.

A CORRECTION

The undersigned wish to give widest possible publicity to correction of an error made by them in regard to a possible southern outlet in Pleistocene time to Lake Coeur d'Alene. This on more careful examination proves to be a misapprehension. Our attention was first called to our error in July of 1927 by Dr. Bretz and afterward his position verified by us in the field. We find that should the water have reached a height to overflow in the supposed channel it would have found an outlet further to the West over the basalt. This error was made in the discussion of a paper before the Northwest Scientific Association by Laney and Anderson and later appeared in the June number of Northwest Science (**1**: 40-41. 1927)

Thomas Large
W. A. Rockie



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Forest Research Activities in the Northern Rocky Mountain Region*

R. H. WEIDMAN

It is not generally realized, perhaps, that forest land comprises seventy-eight per cent of the total land area of northern Idaho and western Montana. With so large a proportion of the region in forests, it is natural that forestry should figure importantly in its economic life. This finds expression in an annual harvest of forest products amounting to $50,000,000 and in the employment of more people in the forest industries than any other manufacturing industry in the region. To perpetuate the forest industries it is necessary to keep forest land continuously productive of timber. And here is the field of forest research. As there are five distinct types of forest in the region, which vary in their habits of growth and reproduction, and in their reaction to fire, disease and insect attack, as well as in the conditions of soil and climate under which they grow, it can readily be realized that there are numerous problems needing solution.

The mention of forest research to the average person interested in forestry probably brings to mind the Federal Forest Service, and more particularly the forest experiment station, as the sole agency engaged in this field of scientific endeavor. Actually there are at least a half dozen agencies in the region which are engaged in some phase of forest investigations. These are the Forest Service, the Bureau of Plant Industry, the Bureau of Entomology, the Weather Bureau, and the Universities of Idaho and Montana. A limited amount of investigation is carried on now and then by private agencies.

On the basis of time spent by permanent members of staffs, the research activities of the Forest Service represent the full-time efforts of nine men, and the combined activities of the other agencies would approximately equal the full-time employment of ten men. In the way of funds, a total of about $88,000 is expended annually in the region as follows: Forest Service, $38,200; Bureau of Plant Industry, $30,800; University of Idaho, $9,300; Bureau of Entomology, $6,000; University of Montana, $2,200; Weather Bureau, $1,500.

Altogether the several agencies list close to a hundred research projects of greater or less magnitude. To give an idea of the extent and character of the field covered, the more important of these projects will be enumerated. These will be listed briefly according to the agencies conducting them.

The Northern Rocky Mountain Experiment Station has a permanent staff of five men. Its program contains fourteen projects. Six of these are of major importance and require most of the time of the staff throughout the year; the remaining eight require only periodic attention. Because of limited funds and the advisability of concentrating rather than spreading its effort ineffectively over the region as a whole, the Experiment Station has confined its project work for the last sixteen years, with one exception, to a single forest type,—the western white pine forest of northern Idaho and the extreme western edge of Montana. This type contains both the greatest commercial values and the most pressing problems. The Station projects, with the six of major importance listed first, are as follows:

* This and the following papers were delivered at the last annual meeting in Spokane, December 28 and 29, 1927.

1. Methods of harvesting the timber crop with a view to securing reproduction of the desired species.

2. Factors affecting natural reproduction, including production, dispersion and germination of seed, and establishment of seedlings.

3. A growth and yield study.

4. Relationship of weather conditions to the inflammability of forest fuels and to the behavior of forest fires.

5. Behavior and characteristics of lightning storms as a cause of forest fires.

6. Basic silvicultural and protection requirements for growing western yellow pine as a crop. This is the only project conducted outside the white pine type.

7. Methods of thinning young stands to utilize intermediate harvests and produce maximum yield per acre.

8. Forest types of the region and their climate controls.

9. Maintenance of special forest weather stations with a view to localizing fire-weather forecasts, in co-operation with the Weather Bureau.

10. Chemical weed eradication in forest nurseries.

11. Stimulation of growth of Engelmann spruce in forest nurseries.

12. Controlling root development in forest nursery stock with a view to insuring greater survival in field planting.

13. Influence of brush in aiding survival of field-planted stock.

14. Management of a field labratory and demonstration forest of 4,000 acres near Priest River, Idaho.

In the case of most of the projects of the Experiment Station the work is largely done on permanent sample plots. Altogether there are sixty larger plots devoted to growth, yield, thinning, and methods of cutting, and over five hundred quadrats given to the study of natural reproduction. In the case of some of the projects considerable work is done by instrumentation in the field and laboratory.

In the Forest Service also the Office of Forest Management has supervision of two research projects upon which work is done periodically. One of these involves six thinning plots in western yellow pine stands in eastern Montana, and the other deals with the growth of reserved lodgepole pine stands after cutting. The Office of Forest Products has a staff of three men and carries a program of seven projects. These deal with: air seasoning; logging output; woods utilization; efficiency of sawmill production; moisture content of lumber; preservation of poles, posts, ties, and mine timbers; and a study of little-used species, including western larch, white fir and lodgepole pine. The Office of Grazing does a small amount of research work in eastern Montana dealing with: (1) proper season of use of range; (2) proper methods of handling stock; and (3) deferred and rotation grazing of sample areas.

Outside of the Forest Service, the Bureau of Plant Industry confines most of its research to the western white pine blister-rust problem. Its program contains six projects which apply to this region. These are the following:

1. Methods of Ribes eradication under different conditions. This includes hand pulling and chemical eradication.

2. An ecological study of Ribes to determine growth forms and habits, seed production, germination, and establishment of seedlings, as well as environmental conditions favorable and unfavorable to Ribes.

3. Rate, distance, and methods of spread of the blister rust.

4. Influence of weather conditions upon spread and development of the blister rust.

5. Susceptibility of the various species of Ribes and their capacity to infect pine.

6. Characteristics of blister-rust damage to western white pine trees.

Although the work of the Bureau of Entomology in this region is largely devoted to control measures, some effort is given to research work. The program which is listed for this region is as follows:

1. Analysis of actual control projects with a view to developing better control methods.

2. Periodicity of epidemics and possibility of forecast.

3. Relation of condition of trees to primary attack by bark beetles.

4. Relation of logging slash to insect damage in standing green trees and reproduction.

5. General biological and ecological studies of economic species of defoliators.

The research work of the Weather Bureau Office at Spokane involves the part-time efforts of one man who cooperates with the Experiment Station in the study of meteorological conditions taken at special forest weather stations.

In the case of the Forestry School at the University of Idaho, the faculty members give twenty per cent of their time during the teaching year and their full time for two months each summer to forest research work. Frequently two or three field assistants are also employed on the work in the summer. There already exists a good nucleus of permanent sample plots in growth and yield. The research program contains the following projects:

1. A growth study of residual stands left after logging, dealing both with western white pine and with western yellow pine.

2. A yield study of young even-aged stands, devoted to western white pine and to western yellow pine.

3. Nursery experiments in shading, mulching, and chemical weed eradication.

4. Effect of size of trees harvested on logging costs.

5. Value of farm windbreaks.

6. Ribes studies in cooperation with the Office of Blister Rust Control dealing with: (a) influence of burns on Ribes occurrence; (b) germination tests of Ribes seeds; and (c) an effort to determine whether Ribes seed is stored in the duff.

7. Pathological studies dealing with cull per cent due to rot in standing timber, deterioration of logs in storage, efficiency of chemical end coatings on logs left in the woods or stored, and outward signs of decay in standing timber.

8. A group of laboratory experiments in forest products as follows: (a) suitability of western red cedar for cigar box stock; (b) decay resistance of native woods; (c) moisture content of bull pine and western yellow pine; (d) cause and control of kiln brown stain in lumber; (e) thermal conductivity of wood at various moisture contents; (f) factors influencing the movement of moisture in wood and the relationship of shrinking and swelling; (g) utilization of blued match stock; (h) inflammability of various forest fuels at different moisture contents.

The forest research work at the University of Montana is incidental to teaching. It therefore comprises but a small part of the time of the faculty during the school year. The projects listed by the Forest School are as follows:

1. Production and viability of seed of forage plants.

2. Shrinkage of woods native to western Montana from a green to an oven-dry condition.

3. Electrical measurement of moisture content of wood.

4. Effect of alignment, curvature, grade, slant of trough, and super-elevation in log chutes.

5. Observations in cut-over stands in the larch-fir and western yellow pine types.

6. Yield study of even-aged western yellow pine stands.

7. Test of exotic species for forest and shade tree planting in Montana.

The research program of the botany department of the University of Montana contains two projects bearing on forestry. One of these is an ecological study devoted to plant succession and the factors controlling plant asociations. One of the results is a published monograph entitled "Forest Distribution in the Northern Rocky Mountains." Another report now in preparation is entitled "Vegetation Zones of the Bitterroot Mountains." The other project is a cryptogamic survey of the region, in which special attention is to be given to the forms of rust fungi and those members of the Agaricales which cause economic losses among standing trees, logs, and lumber.

Listed in this way, the forest research activities of the different agencies in the region make quite an imposing program. Questions that immediately arise are: What is the interrelationship of these various lines of work, and what has been done in the way of correlation of the research efforts of the different agencies?

It is helpful to a ready understanding of the interrelationship of the various projects to consider them from the point of view of four major lines of forestry effort, viz., forest management, forest protection, forest utilization, and grazing. With forest management constituting the growing, harvesting and replacement of timber crops, there is little difficulty in recognizing the close relationship to it of the studies of growth, yield, thinning, cutting, reproduction and artificial reforestation. To forest protection belong the fire studies, fire-weather forecasting, insect investigations, and the pathological studies in connection with white pine blister rust and the wood-destroying fungi. All of these studies are aimed at safeguarding the growing timber crops, as well as the harvested products, against the various destructive agencies to which they are subject. To grazing research belong the studies of range vegetation, the proper handling of livestock on forest ranges, and the highest grazing use of these ranges compatible with the primary function of timber growing.

Upon superficial consideration utilization research, which embraces the logging and sawmill studies, wood preservation and lumber seasoning studies, and investigations of the physical properties of wood, seems to be more closely related to industry and commerce than to timber growing. Its relationship to forestry is apparent, however, in examining its true aims. For example, studies looking toward the elimination of waste in logging and lumber manufacture make the products of the forest go farther, as do also improvements in lumber seasoning, chemical preservation of timbers, and the discovery of new uses for parts now culled or serving inferior purposes. Thus utilization research, by making the products, serve their maximum usefulness helps to bridge the present undesirable gap between a large annual lumber cut and a small annual growth, and thereby contributes directly to less heavy methods of cutting in the woods and more suitable conditions for growth and regeneration of timber crops.

Fundamentally, there is the closest relationship between these several lines of endeavor,—an essential unity which is based on the forest as a biological unit. The trees of the forest are only one part

of this unit. Other parts are the fungi and insects of the forest, and the disturbing forces of man and nature represented by logging, storms and forest fires. Still other parts are the soil, the climate, and the subordinate vegetation. This close relationship of the parts is sometimes lost sight of when they become separate subjects for research by the various agencies.

What has been done in the way of correlation of the research efforts of the different agencies? In the Forest Service there is a District Investigation Committee, which meets in January each year in Missoula. This committee is composed of the heads of the Experiment Station and the offices of Products, Management, Grazing, and of other lines of Forest Service work which are closely interested in forest research. During the last two years the heads of the blister rust, entomology, and weather bureau work in the region, as well as the deans of the forest schools, have attended the meeting as advisory members of the committee. This year the State Foresters of Idaho and Montana have also been invited to participate in the meeting. The function of the committee is to go over the progress and plans of the several research units and to approve and co-ordinate the work for the following year. This annual meeting is beginning to serve as a means of co-operation and co-ordination of research efforts outside, as well as inside the Forest Service.

In the case of larger forest experiment stations in other parts of the country, there are regional advisory committees for each station, the members of which are formally appointed by the Secretary of Agriculture. With the rather limited funds for the forest experiment station here, it does not seem necessary to have a formal advisory committee in this territory. Where the activities of the various agencies are still limited, and much of the work of a preliminary and empirical character, as is the case here, it is believed to be more important to get research under way than to attempt correlation on too elaborate a scale. This is particularly true in the case of the agencies where research is incidental to teaching, administration, or to the operation of control measures.

This paper would not be complete without a word regarding the forest research needs of the region. The problems involved in the wise and economic management of its forest resources are many and difficult. The projects listed in this paper indicate the number and complexity of these problems. As in other lines of commercial enterprise, so in the forest industries, dependence must be upon research for the solution of these problems. Present funds for the activities of the various agencies are altogether too small to meet the needs. They are, in fact, an insignificant portion of the values involved, amounting to less than two-tenths of one per cent of the annual value of the forest products of the region, and but an infinitesimal proportion of the total capitalization of the forest industries. The needs of the region really require an expenditure of funds of two or three times that which is now available.

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Some Forest Problems of the Northwest

Particularly As They Relate To Sciences Other Than Forestry

THORNTON T. MUNGER

It is not uncommon for foresters to argue among themselves "What is forestry?" Some say it is primarily engineering, others that it is business management of forest property, others that it is fundamentally the science of forest life, and still others that it is just the art of growing forests. Each group is inclined to define forestry according to its particular sphere of work. Those having principally to do with the organization of a logging enterprise think of forestry as essentially engineering, the Forest Supervisor's job inclines him to view his work primarily as one of business administration, the forest protectionist thinks of himself as an organizer and publicist, not a scientist, while those who have the cultural operations of marking trees for cutting, the making of thinnings, the propagation and planting of trees must be artisans. But behind this employment as engineer, administrator, or artisan, there must be a background of scientific knowledge. The practicing forester, whatever his specialized duties may be, uses as his stock in trade the facts which the science of forestry discloses, and shapes his administration accordingly.

The Society of American Foresters has defined forestry as—"The science and art of managing forests in continuity for forest purposes, i.e., for wood supplies and forest influences". That recognizes that forestry is both an art and a science. It is about the science of forestry that I will speak today—the systematic classified knowledge useful in the practice of forestry, both that already at hand and that which is yet to be sought out by research.

Webster classified forestry as one branch of economic botany. It is more than that. The science of forestry is really a composite of several sciences. It is not at all elemental, but an alloy of most of the biological and some of the physical sciences, and is still quite unstable in its compounds. In speaking of some of the forest problems of the Pacific Northwest, which are calling for solution and many of which are already engrossing the attention of research agencies, I want particularly to bring home to you the dependence of forestry upon the basic sciences.

Certain of the relationships are so obvious as hardly to merit mention, for example the forester's need for the chemist in the utilization of forest products. A tree is one of the most interesting and varied chemical compounds whose possibilities for use the industrial chemist alone can disclose. A tree is subject to mechanical and physical laws, its very existence is dependent upon its reaction to earth, air, fire, and water. Here the forester must call in the physicist to explain some of the phenomena he observes. Insect pests and diseases of one kind or another obviously demand as one phase of forest protection the entomologist and pathologist. The forester can not describe the forest and environment under which his trees grow unless he be something of a systematic botanist, a geologist, a physiographer, a climatologist.

The science of American forestry is still so new that there is at present great occasion for descriptive and empirical studies, and they have immediate application in forest management. But the ulti-

mate solution of silvicultural problems demands knowledge of the fundamental principles which control tree life and forest societies. Forestry now needs research both of an empirical and fundamental character and both kinds involve a very broad field, touching many subjects beside just trees and woods. They go along together and I shall attempt no distinction between them.

There is considerable analogy between forestry and her sister applied science in agriculture in their dependence upon the the biological sciences and in their research needs. I expect forest research to pursue during the next two or three decades much the same course that agricultural research has during the last thirty years. Any research in forestry is almost sure to lead the investigator quickly into fields outside of his particular sphere and into the realms of chemistry, soil science, biology, botany, genetics, or what not, where he must either seek the help of specialists or be satisfied with a half solution of his problems.

I would now like to point out some of the interesting ways in which certain of the sciences are fundamental to forestry and have application in the solution of forest problems. They are given by way of illustration, quite at random, without any attempt at an orderly or complete exposition of the relation of forestry to all its allied sciences. Take soil science, for example. It is generally conceded that in this country the knowledge of soils is quite in its infancy. An understanding of forest soils has hardly been born. Foresters are realizing, however, that the soil is more than just a pediment upon which the trees stand. It is from the soil that the trees maintain their vitality. The growth that the forest makes depends upon the composition and condition and biology of the soil. How can the forester classify land as to its possibilities for tree growth unless he knows soils? Knowledge is lacking as to the qualities that go to make up the optimum soil for each kind of tree, for not all species have the same requirements. Nor have the standards for describing and sampling forest soils been worked out. Of soil surveys within the forests there are almost none in the Northwest. They cover well the lands of agricultural possibilities and are naturally made from the point of view of the agronomist. We need studies of forest soils for purposes of description and classification and still more for explaining the relation between soil properties and tree development.

It is a common error among foresters to think that because forest soils could not be plowed or disced or manured that there was no use in knowing anything about soil science; that nothing could be done about it, if the soil was not in as good condition or as fertile as it might be. That is a mistake for forest soil is not static, and there is a good deal that foresters can do to affect its qualities. Here is an instance. In the much admired artificial forests of Saxony with their generations of spruce woods without underbrush and with close utilization, the productive capacity of the ground has fallen off to a degree that alarms the German forester. Under the artificial conditions of intensive silviculture and utilization the soils have deteriorated and it is a problem for the soils student and the forester to work out a woods technic that will bring the fertility back. We know that the logging operation with its attendant admission of light, encouragement of sheet erosion, etc., is a terrible shock to the soil. What damage do our forest fires do to the soil measured in terms of soil productivity through a term of years? What does our prevailing practice of slash burning do to the soil's tilth and to its micro-organisms? Burning is probably good for some soils; but bad for others. Where should it be tolerated and where tabooed?

Slash disposal is one of the ways that the forester has of influencing soil conditions, if he only had the knowledge upon which to act intelligently. There are other processes of silviculture that should recognize the demands of good soil management. Clear cutting, in contrast to selection cutting, may have a profound effect on the soil. The mixture of species affects the acidity of the soil. The beneficial effect of certain hardwoods when in mixture with conifers has recently been pointed out. Certainly the forester ought to decide upon the method of cutting he will practice and the mixture of species he will strive for, with full consideration of the soil reactions that are involved.

The grazing of stock must have an effect on the soil and perhaps actually affect its productivity for forest growth. There has been some speculation in this field, but a systematic research only in woodlots and pastures. It is conceivable to think that the presence of stock might act favorably in some instances and the opposite in others. There is the mechanical effect to consider as well as the effect on the removal, or rather conversion, of the annual herbage and undergrowth. Where are the facts?

Soils may deteriorate in the uncut forest or they may improve; with the knowledge of the fundamentals of soil physics, soil chemistry, and soil biology furnished by the soil scientist the forester can use his ingenuity to devise a system of forest management that will allay the unfavorable or bring about the favorable conditions.

Now pass to the science of botany, of which certain phases of forestry are really a part, for trees are quite the most important members of the vegetable kingdom. Every forester has to be or should be something of a botanist. He should have a working familiarity with the names of the plants that constitute the forest society, he should know at least the high lights of plant physiology, and morphology. If he is a specialist he must, of course, know much more, even for empirical research in forestry. There is an immense amount of fundamental research in the life processes of trees which the botanist should do. I do not belittle the past achievement, of botanical research in saying that there is a storehouse of fundamental knowledge about the physiology of trees yet unopened,—their anatomy, chemistry, and relation to waeer, light, and soil. There are 850 different tree species in the United States, 65 of them of large commercial importance, and every one has a different set of requirements and behavior.

Some recent fundamental studies in the physiology and morphology of resin formation in pines has had large practical application in naval stores production. The whole field of the relation between growing conditions and the chemical and mechanical properties of wood and its secondary components is most enticing. Another practical field is seed production. What makes the great irregularity in seed production and to what extent can the forester control this element in regeneration? There is much that the plant physiologist might do in unraveling the mysteries of inflorescence, fertilization, seed vitality, of germination, and seedling survival.

Of late ecology has been a branch of botany that has caught much attention and the significance of forest ecology as a scientific basis for forest management is patent to even the most untheoretical forester. How little we know, however, about the relationships of plants to each other and to their site. I should like to know what are our plant indicators here in the Northwest, if any; and what are the stable plant communities and what the temporary? It is the very backbone of silviculture to know the natural cycle of vegetation and the factors that alter it one way or the other. Without a knowledge of ecology the forester can not

hope to purposefully alter the composition of his forest,—yet what wonderful opportunities there are to improve on Nature, impudent as that may sound. To make white pine in the majority instead of the minority in North Idaho, to increase the proportion of the valuable spruce in the hemlock-spruce forests of Southeastern Alaska, to keep the ideal balance of species to get maximum returns in the Douglas fir region would be very desirable.

I have heard foresters discuss why it was that pine seedlings were in some places most numerous in clumps of brush. Is it the protection of the seed against seed eaters, or of the seedling against grazing stock, or is it a matter of shade or a diminution of competition from sod or other plants that feed at the same soil stratum? A simple thing to find out for a specific case, no doubt, but the woods are full of such problems that invite study. A certain type of herbage may be the cause for the scarcity of reproduction on an unfavorable site, or another type may be an encouraging factor to tree seedlings. Knowing this the forester can perhaps bring about by the appropriate methods of cutting, by fire, or by grazing the type of ground cover that favors forest regeneration.

Phenology is a rather neglected phase of botany and I can find but few references to work done in this country. Observation of the time of leafing, flowering and fruiting of all economic plants, including trees, is certainly of practical use. The forester is interested in knowing the time that his trees ripen and disseminate their seed, when germination starts, the length of the growing season for different species, when growth starts and ends on various sites. From the point of view of fire control it is important to know when the trees pass the succulent, less inflammable stage and take on a drier condition of foliage. The inflammability of the forest can also be reckoned to a certain extent by the seasonal stage of the lesser plants. Their water content goes through a great transformation during the vegetative period.

From the point of view of grazing administration phenological observations are quite necessary and more has been done to serve this use than any other, so far as I know. The life history of the range plants should be known and the use of the range modified accordingly. The flowering or withering of certain herbs is taken by the grazing specialists as an indication of range readiness. So forest phenology ties in closely with the phenology of all the wild flora. There is probably a nice correlation between the seasonal habits of the trees and of cultivated crops. Were they known the easily observed habits of the farm plants might be used as an index to conditions in the forest.

There is much more to phenology than merely tying into the seasonal behavior of the trees and plants with calendar date, interesting as that is. It is still more interesting to relate the condition of the plants with climatological factors. This is a line of study by which the principles can be learned. What are the cumulative weather conditions that start growth, that terminate it, that bring each of the lesser plants to the point of withering, that favor seed production? Knowing these principles the technical forester can predict a few weeks in advance when the range would be ready, when the forest would become inflammable, when germination would start, and perhaps even predict seed crops. In short he could recognize an "early season" or a "late season" or a "normal season" in terms of vegetative condition ahead of time.

Genetics is another branch of botany of immense importance in forestry, as in all the biological sciences. Foresters must look to the specialists in this field for help in their problems, and it is already being given in two or three instances in this

country. Forest tree heredity is perhaps a rather uninviting field for the geneticist, unless he have uncommon patience, for the life span of a tree is so much longer than that of man. What characteristics of trees that affect their economic value are hereditary and what are not? Are the qualities of spiral grain, susceptibility to diseases, or slow growth transmitted? If so it is high time that great care were exercised to avoid such parents in leaving seed trees or in gathering seed for artificial reforestation.

Again, the several regional races of a single species offer most interesting study to determine how much it is environment and how much heredity that makes the difference. Such knowledge will help the forester to select intelligently the source from which he collects seed and so perhaps increase greatly the vigor and growth of the next crop. The actual controlled breeding of trees to improve the race involves many technical difficulties and a long term of years but the possibilities are so great that it is a worthy field for genetic research.

Last winter the *Journal of Forestry* carried an article under the title "Wanted—A Forest Biologist," in argument for the study of animal life as it affects forestry. Here again are most interesting relationships, of which I fear foresters know only the most obvious. We hear a good deal about the biological balance, but go about preserving it very crudely, if at all. Coyotes kill sheep, so we kill coyotes. Thereupon rabbits and porcupines increase and girdle our young pines to an alarming degree. Mice and chipmunks are sometimes good planters by burying seed the proper depth for germination and then forgetting it. But they also eat a great quantity of seed. Are they benefactors or enemies of economic forestry? Why are bark beetles seemingly very numerous where there is smoke, —do they like it or is it because their predators are driven away by it? The forest biologist would study the life cycle, habits, and needs of all the forest fauna as they may influence forest management, so that the forester can act intelligently in preserving the proper balance of all wild life, including the game itself. The solution of many a problem of forest regeneration or ecology may be found not in the behavior of the vegetable kingdom, but in the habits of the forest animals. Man is by no means the only animal whose conduct has a profound effect on forest perpetuation.

The comparatively recent movement to get on top of the forest fire demon by rearch as well as by strong-arm methods has necessitated going far outside the field of forestry for help. One interesting development is in meteorology. Of course there is a close relationship between weather and forest fires, but just what weather conditions are provocative of great conflagrations,—is it high temperatures, winds, lack of precipitation, low absolute humidity, or low relative humidity? How can the cumulative effect of the crucial weather factor upon the forest fuel be expressed? These are very practical but very puzzling questions for the meteorologist-forester to answer. The knowledge that a certain kind of weather is provocative of the bad spread of fires, and it seems to hinge largely on humidity, makes it desirable to predict the coming of that type of weather. So the obligation falls upon the meteorologist to predict weather factors that have heretofore been considered of little moment. This is the fire-weather warning service of the Weather Bureau. It is agreed that much more research in meteorology is necessary to understand thoroughly the dry spells of these western mountains and to predict them.

There are, of course, many other phases of meteorology and climatology in which the forester is interested. Clima-

tic cycles are of great interest for they tie in with growth and yield studies. What is it that limits the natural range and the possible artificial extension of redwood or Port Orford cedar? The effect of each climatic factor on the survival and the rate of growth of different species is very important, as for example a high degree of cloudiness or "filtered sunshine." Is that what makes the big trees of the Pacific seaboard? Or does this lead us into the field of optics rather than climatology?

Mathematics is a tool that is as useful in forest studies as anywhere. A tree is such an exceedingly difficult object to measure, and a forest still more so, that forest mensurational studies are highly specialized. It is said that there are not over a dozen men in the United States who are masters of the technic of forest mensuration. In spite of all that has been done in Europe to perfect the methods of measuring the forest crop and its rate of growth, research in forest mathematics is constantly adding to the understanding of the underlying principles.

I might go on down the list and show that several other sciences were involved in forest research, but the above samples will suffice to make my point clear.

The ramification of problems in forest management is beautifully illustrated by a study of slash disposal which is in progress in both Oregon and Washington. The debris resulting from logging presents one of the acute problems of the region. It is a situation common to all forest types and separate studies are under way in both the pine and the fir belt. To leave it is to invite fire; to burn it has also its grave disadvantages. The forester should know the facts by which he can measure the advantages and disadvantages of each method of slash disposal for each type of forest. Let me just hint to you a few of the avenues for investigation that such a problem must travel.

Since about the only reason for slash burning is to abate a fire hazard, it is a nice question to decide to what degree burning the slash really does lower the hazard through a term of years in comparison to letting it lie. What shall be the measure of inflammability? This is a question of technic that immediately requires a knowledge of combustion. Here the physio-chemist is needed to analyze how the chemical content of the slash, its moisture content, and its position affect inflammability.

Likewise entomology is immediately drawn into this investigation to determine whether leaving the slash unburned will furnish an unduly favorable breeding ground for insects that might be dangerous to the living trees, or will it have the opposite effect and attract injurious insects away from the green trees, or perhaps the slash will stimulate the predators more than it will the tree pests themselves. The pathologist must study an analogous situation for the rusts and other fungous diseases. Is burning a wise sanitary measure for the residual forest or does it have an opposite effect? He can also tell the forester how to leave the slash that it may decay the fastest, whether flat on the ground or loose, and how long it will take to disintegrate on different sites. The forest biologist is needed to show how logging and slash disposal will affect animal life and to what extent it will upset the symbiosis of the forest trees and fauna, if it may be so called. Such a severe broadcast slash burning as is practiced in the Douglas fir region may have a very profound effect on the small animal life. It may exterminate some and may require others to change their food habits. Perhaps killing off by fire the mice and squirrels which otherwise would eat much of the seed cast by the seed trees may help reforestation. The extermination of burrowing animals may actually be a very bad thing for the soil. That suggests the need for remembering the tre-

mendous effect that fire may have on the soil; and this factor must be put into the balance in weighing the merits of each method of slash disposal. How does the fire affect soil acidity, does the removal of the litter expose the surface to erosion, does the loss by combustion of the vegetable material impoverish the soil?

The ecologist, too, has a place in such an investigation, for the type of lower herbage that follows logging may be determined to a considerable extent by the slash disposal practice. Broadcast burning induces the growth of certain annuals, which would not appear if the slash were left as it fell. It is important to know whether these are permanent or transitory, how they affect the fire hazard, how they alter grazing possibilities and affect range values, how they tie in with tree reproduction. It would be a fascinating and very useful study for an ecologist to determine the principles of succession on cut-over areas as affected by different methods of slash disposal.

In selecting an ideal method of disposing of logging debris for a certain type the subtle secondary factors, which I have hinted at above, should be given perhaps quite as much consideration as the obvious economic considerations, or the direct relationships to tree reproduction.

I hope that these rambling instances of the inter-relation of forest problems with other fields of research in the natural sciences have indicated the need for close contact between foresters and the specialists in other subjects. Just as forestry is a compound of many sciences, and the forest itself is a complex society of plants and animals, so foresters should be many sided, and learn to see beyond their own speciality. The research forester in his daily work must apply the knowledge of the sciences fundamental to forestry—botany in all its branches, meteorology, physics, chemistry, biochemistry, physiography, and so on down the list of most of the biological and physical sciences.

But it is more than a matter of just using what the other sciences can already furnish. There is a great unexplored field for research in woods life to give the knowledge necessary for good forest management and protection. Some of this can be done by foresters with the ordinary, advanced forest school education, some should be done by foresters with a specialized training in some field, and some must be done by scientists trained wholly in departments other than forestry. I hope that foresters may appreciate the great breadth of their profession and not limit attention merely to the trees themselves, forgetting the soil beneath and the clouds above, the lesser plants, and animals. We must recognize the need for the help of the students in other fields in solving our problems and endeavor to effect the closest possible cooperation. I hope further that the forest may attract even more than it has before research scientists of many departments, and that they may investigate all of these problems of woods life and environment that have such great possibilities for useful economic application.

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Red-Ray Rot In *Pinus Ponderosa*

ERNEST E. HUBERT

Red-ray rot is a cull-producing rot common in western yellow pine (Pondosa pine) heartwood, and has undoubtedly been confused with the red-ring rot of conifers, but is caused by a white-colored fungus, *Polyporus anceps*. (1). It is a trunk rot, and is often characterized by a peculiar radiate outline when viewed in the ends of logs in contrast with the red-ring rot, which is irregular to crescent shaped in outline. The rot appears to be well distributed throughout the yellow pine regions, and is common as a top rot, which is almost invariably associated with spike topped or broken topped trees in most areas. A similar rot is common in yellow pine of the southwest, where it is known as "western red rot". (2).

Rot Description

In the early stage, the infected wood shows a reddish to reddish brown discoloration, the outer margins of discolored wood showing numerous radiate projecting areas of decay, like spokes in a wheel. At times, these projections are not pronounced and the rot area may have a general circular outline when viewed at log ends. In plain sawed lumber, these areas often appear as small isolated areas of irregular outline. The discoloration is usually of a darker brownish shade than found in the early stage of red-ring rot. The white pockets have not yet formed in this stage, and no evidence of a hidden stage has been found. Resin infiltrations in the areas of early decay are not common in this rot.

In the late stage of decay, the wood between pockets is of the same color as in the early stage, but contains numerous white pockets which have a tendency to form in the spring wood and run together in the direction of the wood fibers. The pockets are of about the same size as in red-ring rot, but have blunt to squarish ends, and are much larger in the sapwood than in the heartwood. The tendency to run together, ring scale and form long white patches is greater in the sapwood. In this stage, the wood is markedly weakened and in older rot the infected area becomes soft and spongy. In the sapwood the rot often shows a white mottled pattern when viewed in tangential cut. The infected wood is easily pulled out from the ends of logs and in some cases small hollows are formed in the central part of the decay cylinder. No zone lines similar to those found in red-ring rot are to be found. In the very late stages of decay, the pockets may be empty of white fibers.

In spruce there is a tendency to ring scale with smaller pockets, which at times show black flecks in the centers. Black flecks are sometimes found in the rotted sapwood of Pondosa pine.

Red-ray rot is a typical trunk rot occupying the heartwood of most of the trunk from the base well up into the top. The rot column is roughly conical usually extending from 12 to 20 feet up the trunk in all but the oldest trees where the decay may extend higher. In certain regions, it appears as a typical top rot associated with injured or spike-top trees. In such cases, the rot may extend 15 to 40 feet downward from the lower end of the dead top.

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(1) Hubert, E. E. Manual of Wood Rots for Cruisers and Scalers of the Inland Empire. 65pp. 1927. Reprinted in field book form by The Timberman. Portland, Oregon.

(2) Long, W. H. A Preliminary Report on the Occurence of Western Red Rot in *Pinus ponderosa*, U. S. D. A. Bulletin 490:1-8. 1917.

Outward Signs of Decay in Trunk or Logs

The conks of this fungus are small, white to cream colored, and somewhat irregular in shape. Occasionally they appear as short, thick, shell-like projections from the sides of logs and stumps, but usually they are in the form of thick, flat sheets of whitish fungous growth attached to the under surfaces of logs. The surfaces show numerous tiny holes or pores except at the margins, which are smooth. New conks are produced each year, and the old ones are rapidly destroyed by insects and other agencies. The conks are rarely found on living trees, but are common on stumps, logs, down timber, and slash. Small flattened conks are often found in the spaces between the loosened bark and the infected sapwood of stumps.

Punk knots are rare in standing trees, although occasionally they are to be found on logs. When found, they usually show a small amount of whitish punky growth at points where dead branch stubs once protruded from the bark. Soundings on the trunk will indicate presence of heart rot as in other trunk rots.

Since most of the infection enters the living tree by way of branch stubs and dead tops, a large number of broken branches and injuries to the top may indicate decay. Fire scars at the base of the tree are also points of entrance for the fungus. The presence of woodpecker nest holes also indicates heartrot, although this may not always be red-ray rot as brown-trunk rots are frequently found in the tops.

Little is known regarding the relation of age to amount of decay caused by this fungus, and until field studies yield reliable data, it must be assumed that the per cent of rot increases steadily with the age of the stand. The older age classes showing many trees with injured tops usually show a large cull per cent due to this rot.

The characters of the rot that appear at the ends of logs are of real value in identifying red-ray rot. The star-shaped or radiate outline of the rotted area is very characteristic, but in some logs this character is not pronounced particularly where the rot completely fills the heartwood area. Numerous rays of infected wood extend from the central rot cylinder toward the sapwood. These rays are bordered by reddish brown areas of early decay and usually in the late stage surround grayish white areas of late decay. The central cylinder shows a mass of grayish white, badly broken, spongy fibers in the late stage, while the early stage shows firm areas of a reddish brown color. Small hollows may appear in the central part of butt logs at the basal end.

Red-ray rot in this region has previously been attributed by scalers and cruisers to the attack of the red-ring rot fungus, *Trametes pini*. The red-ray rot, however, differs strinkingly from red-ring-rot. In order to bring out more clearly the various differences to be found between these two rots and the fungi causing them, a table has been prepared which gives a direct comparison between the two heart rots. For a more detailed description of the characteristics of red-ring rot, see the "Manual of Wood Rots" previously cited.

Red ray rot is common in the following species placed in the approximate order in which the rot is most commonly found: (1) Western yellow (ponderosa) pine, (2) Engelmann spruce. (3) Lodgepole pine, (4) Western red cedar, (5) Douglas fir. (Also common in Canadian jackpine.)

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Table of Comparisons of Red-Ray Rot and Red-Ring Rot As They Occur in Pinus Ponderosa.

Name of Rot	Causal Fungus	Color of Conk	Type of Conk	Early Stage of Rot	Late stage of Rot in flat or edge Grain	Zone lines	Rot Area, end of Log	Effect on Wood	Culture in Malt Agar
Red-Ray Rot	*Polyporus anceps*	White	Small, annual, rarely found on living tree	Reddish to reddish brown color	White pockets with blunt or squarish ends	None	Radiate, spoke-like (1)	Soft, weak, and no uses	White with formation of poroid areas
Red-Ring Rot	*Trametes* pini	Brownish	Large, perennial common on living tree	Pink, reddish to purplish color	White pockets with pointed ends	Often with narrow black or brown lines	Circular, crescent-shaped	Hard, considerable strength. Several uses	Brownish, no poroid areas

(1) In some logs, this character is not pronounced, particularly in some cases where the rot completely fills the heartwood area. At times, small hollows may appear at the basal end of the butt log.

The Life History of Some Western White Pine Stands on the Kaniksu National Forest

ROBERT MARSHALL

On History, Human and Arboreal

There are certain phases of human knowledge which we all recognize must rest on biographical studies. History is one, and psychology, which is a sort of a mental history, is another. The basis of study in both cases is the individual; by the critical weaving of the detailed stories of many individuals, generalized deductions may be drawn. But it should be borne clearly in mind that the generalizations are secondary, or possibly teritary processes.

Similarly in arboreal history the source material must be individual. We cannot generalize about the life history of any forest type without starting from specific stands, any more than we can write on Hottentot inhibitions without studying specific Hottentots. Consequently, I will try not to burden you with ponderous but feebly rooted aphorisms, and instead will present a few detailed forest biographies which the Kaniksu trees have been conscientiously keeping in their annual rings.

An All-Aged Stand

In 1610, while Cromwell was celebrating the close of the Thirty Years War by staging a civil war of his own, while infant Louis XIV was starting his long and infamous reign in France, while the thirty-year-old colonies of New England were launching their protest against Britain's policy of commercial egotism, while Isaac Newton was a baby and men were thrown into dungeons for ideas no more radical than that the earth moved around the sun, in that year a great conflagration raged unimpeded in those nameless mountains of Western North America, now designated as Selkirk. No white man had ever penetrated that wilderness, or would for nearly 200 years, and so there were probably only a few savages to gaze terror-stricken through the smoke-choked atmosphere at that phantasmagoria.

It was this fire which annihilated the ancient forest of lower Squaw Valley. The reproduction which followed had barely become well established when a second fire in 1687 killed everything but a few larches.

The great gaps between the widely separated trees were not immediately covered with new coniferous thickets. The exterminated stand, only 37 years old, could not have been a prolific seed producer, and so the bulk of the reproduction must have been dependent on the scattered trees in the dampest parts of the valley, which had survived the first conflagration. From such a seed source one would expect a period of regeneration spreading over many years, and that is precisely what happened. Instead of the concentration of ages into a brief period, as is commonly supposed to be characteristic of white pine, in this stand we find a half century dispersion. Only half of the white pine which were to survive at maturity had appeared within ten years of the second fire, while even after thirty years one fifth of the present white pines had not yet started. As for the cedars, they do not even exhibit the semblance of uniformity, having entered the stand at a fairly constant rate for 240 years. Very few of the hemlocks started within the first thirty years, but since 1715 large numbers have vegetated; to-day 40 per

cent of the trees in the stand are of this species. Both hemlock and cedar began as understory trees, and it has only been the gradual opening of the stand which has given them a chance to enter the main canopy. Even so, their crowns are distinctly below the level of the pines and larches.

From the foregoing it is apparent that this stand does not have the putative even-aged character of the western white pine type. In the Kaniksu management plan it is placed in the 220- to 240-year age class, yet upon analysis we find that only 21 per cent of all its trees started during the preceding 37 years, while a third did not start until more than a century later. The only period not well represented by reproduction was from 140 to 200 years ago. This deficit may have been due to a cycle of scanty precipitation, of which there is good evidence, or to the meager sunlight penetrating to the floor of a young stand which at that time had just attained full density.

The details of age distribution are shown in Table 1.

The Effect of Repeated Fires

In a region with so high a fire hazard as northern Idaho, many stands reach maturity only after enduring several scorchings. Such stands, instead of being all-aged, as the one just mentioned, exhibit several distinct age classes, and several periods devoid of any reproduction.

One stand of this nature had its genesis in 1641, when a great conflagration wiped out all of the former forest except a few cedars. This fire must have been a very hot one, for it spared nothing under fifty years of age, and severely roasted the butts of the thick barked trees which did survive. It seems probable, judging by present form and freedom from heavy limbs, that the new stand was well stocked. Due to the destruction of subsequent fires, however, we cannot determine either the number of stems or their age distribution. We do know that all the merchantable white pine in the mature stand started at that time.

In 1742 a second fire, much less severe than the first, occurred. The stand was opened sufficiently to permit a large influx of new trees, including half of the ultimate hemlocks. The openings made by this light fire, however, were not big enough to permit the establishment of any white pine.

TABLE 1.—Age Distribution in All-Aged Stand

By Percentage—Trees 1″ D.B.H. and Up

Age Class	White Pine	Larch	White Fir	Cedar	Hemlock	Entire Stand
61-80	0	0	0	13	14	8
81-100	0	0	0	8	17	8
101-120	0	0	60	13	17	12
121-140	0	0	40	8	17	12
141-160	0	0	0	8	14	6
161-180	0	0	0	4	0	1
181-200	5	0	0	8	4	5
201-220	30	0	0	21	17	19
221-240	65	0	0	17	0	21
241-260	0	12	0	0	0	1
261-280	0	88	0	0	0	9
Total	100	100	100	100	100	100

By a strange coincidence, after another interval of 101 years, a third fire blazed through the area in 1843. It must have been heavier than the one of 1742, for not only was it completely destructive to the reproduction which had started during the previous twenty years, but furthermore it opened the stand sufficiently to permit a considerable amount of white pine and white fir to start. About 80 per cent of the reproduction following this burn, however, was cedar and hemlock.

As a result of all these fires the mature stand to-day is distinctly four-aged. About four per cent of the trees date back to a period before the earliest known conflagration; 24 per cent started as a result of the holocaust of 1641; 44 per cent came in following the torrefaction of 1742; while the remaining 28 per cent trace their inception to the effect of the 1843 burn. The pine all came into the stand after the heavy first and third conflagrations; the white fir following the second and third; the hemlock started after all three fires, but especially after the light second one; while the cedar was found in the four-age classes. Practically the entire white pine and white fir reproduction became established within twenty years of the fires. On the other hand the cedar and hemlock regeneration spread over the entire period from one burn to the next.

Table 2 shows the age distribution in this stand.

Two other stands were found to be similar in nature to the forest just described. On an adjacent site grew one which differed only from its neighbor in that the last fire had been more intense. As a result half the trees had originated after this coruscation. With such a strong representation in the youngest age class, the stand was so obviously uneven-aged that in marking it for cutting the standard rules were scuttled, and the cut was made to liberate the understory rather than to obtain reproduction.

In the valley of the North Fork of Granite Creek the most extreme case of a many-aged stand was unearthed. Here in 1927 were found evidences of 1, 17,

TABLE 2.—Age Distribution in Several-Aged Stand

By percentage —Trees 1″ D.B.H. and Up

Age Class	White Pine	White Fir	Cedar	Hemlock	Entire Stand
41-60	0	0	11	9	9
60-80	25	70	14	16	19
81-100	0	0	0	0	0
101-120	0	0	3	2	2
121-140	0	0	6	6	5
141-160	0	15	8	18	14
161-180	0	15	12	32	23
181-200	0	0	2	2	2
201-220	0	0	8	6	6
221-240	0	0	4	3	3
241-260	0	0	6	1	2
261-280	75	0	14	4	11
281-300	0	0	0	1	0
301-320	0	0	0	0	0
321+	0	0	12	0	4
Total	100	100	100	100	100

90, 130, 220, 280, 340, and 400+ age classes. Fire scars were found corresponding to the date of origin of all but the two oldest. The trees—white pine, cedar, hemlock, spruce, and alpine fir—grew on a very damp site, where the fires which had repeatedly devastated the neighboring hills merely spotted, or ran in narrow tongues. As a result, only small openings were made which were promptly sown by the surrounding timber.

The age distribution of all trees 1 inch in diameter and over, along a narrow half-acre strip on the river bottom, is shown in Table 3.

An Entomological Variant

On the south slope of Fox Creek are two-age classes, the overstory about 160 years old, the understory around 75. Offhand one would presume another fire romance, but there is not a trace of scorching to be found. But closer examination discloses a different clue, a belt of narrow rings in most of the Douglas firs and some of the white firs from 1852 to 1860. This, of course, is very suggestive of an insect attack, and since the inception of the understory corresponds in point of time to the belt of narrow rings, it seems safe to say that there was a severe infestation of spruce budworm in the fifties. The affected stand, because of its aspect, probably had a fairly high percentage of Douglas fir. When this was killed the consequence was the same as a shelterwood cutting. Within a few years the feeble light which had reached the floor of the dense 85-year-old forest was multiplied many times. As a result, suppressed trees, which had barely managed to survive for one or two decades, were rescued from imminent death, and a great mass of new seedlings became established.

About 40 per cent of the trees which developed as a result of this entomological metamorphosis, had germinated from

TABLE 3.—**Age Distribution in River Bottom White Pine Stand**
By Percentage—Trees 6″ D.B.H. and Up

Age Class	White Pine	Cedar	Hemlock	Spruce	Alpine Fir	Entire Stand
61-80	0	12	22	0	11	12
81-100	0	6	4	0	0	3
101-120	0	0	4	0	22	5
121-140	8	6	22	0	11	12
141-160	0	6	4	0	0	3
161-180	0	0	4	0	0	2
181-200	0	6	9	0	22	8
201-220	34	12	14	0	34	19
221-240	0	6	0	0	0	2
241-260	0	6	9	33	0	6
261-280	50	12	4	0	0	14
281-300	0	0	0	0	0	0
301-320	0	6	4	0	0	3
321-340	8	11	0	33	0	6
341-360	0	0	0	0	0	0
361-380	0	0	0	0	0	0
381-400	0	0	0	34	0	2
401+	0	11	0	0	0	3
Total	100	100	100	100	100	100

one to twenty-five years prior to the epidemic. This really constitutes the distinguishing characteristic of insect as contrasted with fire regeneration. In the latter case there is little or no survival among the trees which start during the quarter century preceding the opening of the stand.

It might be worth noting that there was practically no Douglas fir reproduction during and for five years after the budworm attack. The plausible explanation would seem to be that the insects so weakened the firs that they produced very little seed during this period.

The age distribution in this unburned two-story stand is shown in Table 4.

An Even-Aged Stand

It is well known that on steep gradients forest fires are commonly more severe than on level terrain. In rugged topography, therefore, it is unusual for any but a few very thick-barked trees to survive a conflagration. On such slopes understory trees as cedar, hemlock, and spruce are less common than on the moister sites. If there is a readily available seed source adjacent to the burn, or if a heavy cone crop is borne the summer of the fire and is followed by a year climatically favorable for germination and survival, the new stand will probably become fully established within a short period. When these three conditions—few surviving veterans, a relatively scant understory, and prompt regeneration—are all encountered, then the theoretical even-aged white pine stand is apt to develop.

Such an area was studied on an abrupt, east-facing slope of Granite Creek. The forest on this tract had been practically wiped out in the year 1800. Only four or five larches, then around 150 years old, survived on an acre. But reproduction following this fire was immediate, due no doubt to one or both of the

TABLE 4.— Age Distribution in Two-Aged Stand

By Percentage—Trees 1″ D.B.H. and up

Age Class	White Pine	Larch	Douglas Fir	White Fir	Cedar	Hemlock	Yellow Pine	Entire Stand
31-40	0	0	4	3	4	2	0	3
41-50	4	0	11	6	7	7	0	6
51-60	2	0	33	10	8	11	0	10
61-70	5	0	4	18	8	16	0	10
71-80	15	0	21	45	7	32	0	26
81-90	5	0	0	7	7	9	0	5
91-100	2	0	3	5	7	5	0	4
101-110	1	0	2	2	15	2	8	2
111-120	3	0	0	0	26	7	0	3
121-130	7	0	1	2	7	2	0	3
131-140	8	20	4	1	4	5	8	5
141-150	13	20	5	1	0	2	50	7
151-160	34	40	11	0	0	0	34	15
161-170	1	20	1	0	0	0	0	1
Total	100	100	100	100	100	100	100	100

causes previously mentioned, and within thirty years practically the entire stand had become established. In 1927 it was found that 91 per cent of the trees had germinated in the tricennium which succeeded the fire of 1800.

On the Lack of a Conclusion

And now for the conclusion, — but there isn't any. Perhaps these half dozen forest biographies will be suggestive of the history of similar stands. They certainly will not be made the basis for any generalizing deductions. For I carry to the woods George Eliot's remark that "the mysterious complexity of life is not to be embraced by maxims" or formulae.

Northern Rocky Mountain Forest Experiment Station, U. S. Forest Service, Missoula, Montana.

Scientific Notes and News

It is the plan of the Publication Committee to devote some space in each issue to scientific notes and news of special interest to workers in the Pacific Northwest. It is understood that this territory should include Washington, Idaho, Oregon, Montana and the adjacent Canadian provinces. Notes of new appointments, removals from the territory covered by Northwest Science, gifts for scientific purposes, special appropriations for buildings, meetings of various scientific societies, notable addresses, scientific expeditions or surveys, etc., will be considered appropriate. The success of this section will depend largely upon the response of members and others interested in Science, as the Publication Committee can not manufacture news items, but must rely upon the contributions which are sent in.

The Northwest Association of Horticulturists, Entomologists and Plant Pathologists will be held at Vancouver and Victoria, British Columbia, on June 25, 26, and 27. E. J. Newcomer, U. S. Dept. of Agriculture, Yakima, Washington, is President and F. E. Buck, University of British Columbia, Vancouver, B. C., is Secretary-Treasurer.

Sabbatical leaves for the next College year have been granted to twelve members of the faculty of Oregon Agricultural College, for advanced study or travel. Eight of the number are from the various scientific departments.

At the Nashville meeting of the American Association for the Advancement of Science, Prof. H. B. Barss of Oregon Agricultural College was elected President of the American Phytopathological Society, and F. D. Heald, State College of Washington was chosen for Vice-President.

Dean Edward Ellery, National Secretary of Sigma Xi, comes from Union College to give the annual Phi Kappa Phi address at the State College of Washington on June 8.

Dean F. E. Thompson of the Idaho Bureau of Mines has accepted the Presidency of the Montana School of Mines at Butte.

The third annual excursion of the Department of Geology, Princeton University, with Dr. Richard M. Field in charge, will begin at Ephrata on July 25, with Dr. J. Harlen Bretz, Department of Geology, University of Chicago, as geological guide. Some of the world's most interesting geology will be studied. Students of geology in High Schools and Colleges of the Northwest are invited to join the group. For further information address L. K. Armstrong, 722 Peyton Bldg., Spokane, Wash.

Non-Indigenous Western Yellow Pine Plantations in Northern Idaho

GERHARD KEMPFF

To know and to control the source of seed from which trees are grown for reforestation purposes, is a matter of some importance. This is recognized in general. But what factors, if any, cohibit the use of western yellow pine seed? This species ranges from Mexico to British Columbia and from the Pacific Coast to the Black Hills of South Dakota. It has adapted itself to a variety of sites. To what extent then does the off-spring retain the parental characteristics when removed to another region of its range?

In the effort to illuminate these questions for the west slope of the northern Rocky Mountains, particularly for northern Idaho, twenty-one small test plantations were established on the experimental forest of the Northern Rocky Mountain Forest Experiment Station near Priest River, Idaho. Each of these is a plot fifty feet square planted originally to one hundred transplant seedlings with the exception of four variants half as large in size and number. The tests were started between the autumn of 1911 and the spring of 1917 and thus they are now eleven to sixteen years old. They represent nine climatic units found within the natural range of this pine.

Trees from the southern Rocky Mountain region originated on the Pecos National Forest in north central New Mexico and on the Coconino National Forest in north central Arizona; those from the Siskiyou-Shasta region took birth on the Siskiyou and Shasta Forests; the ones from the Blue Mountains of northeastern Oregon arose on the Whitman and Umatilla Forests. The Salmon River Mountains in southern Idaho supplied yellow pines from the Boise and Payette Forests; the east slope of the central Rocky Mountains furnished them from the San Isabel Forest in south central Colorado and the Medicine Bow Forest in southeastern Wyoming; the Black Hills region contributed its share from the Black Hills Forest and the Custer Forest in southeastern Montana. The west slope of the northern Rocky Mountain region, the proving ground for this pine colony, has the largest representation: one from each of the following forests, the Colville in northeastern Washington, the Kaniksu and the Coeur d'Alene in northern Idaho and the Lolo in western Montana, and three from Bitterroot Forest also in Western Montana. The reason for a triad from this forest is to be found in the fact that much of the western yellow pine seed used in the Northern District of the U. S. Forest Service is collected there. Two of these plots had parents living at the definite elevations of 4,000 and 7,200 feet; the third had its genesis at a supposed elevation of 5,000 feet. Only two of the nine climatic units have but one emissary. The Wasatch Range conditions of northern Utah are portrayed in the behavior of the trees from the Ashley Forest, while the Helena pines reflect the characteristics found in central Montana.

The plots are located in an appropriate block. The site is a rather dry, flat and uniform glacial outwash of deep, fine sand and interspersed gravel. Sixteen years of weather observations made nearby show that the annual air temperature may vary between 30° F. below zero and 100° F. and that the normal is about 43°. This mean is apparently well below the half mark in the range of mean annual

temperature approximations for the climatic varieties under trial. The annual precipitation has varied from 24 to 41 inches, but its normal of about 30 inches is above the average of the corresponding precipitation limits. (In the absence of exact climatological data for the various points of seed collection, the approximations used in this paper have been based upon records obtained at the nearest weather station, usually less than twenty-five miles distant, and upon data found in Bulletins Q and W of the Weather Bureau.)

Here it is well to impress upon our minds that, unfortunately, there were insuperable obstacles when the investigation had its inception. Their existence then does not now permit deductions as unaffected as could be expected otherwise for the short duration of the experiment. Neither the funds nor the personnel were available to carry the study to the point of fundamental exactness. If the test was to be started at all, it was necessary to make the best use of the existing conditions. Most of the seed procured had been gathered for less exacting purposes. Therefore, detailed knowledge of the seed source is wanting. Such site factors as local climate, aspect, water and soil relations are not known, anymore than individual parent characteristics. Only general points on location, elevation, climate and habits of the variety could be obtained.

In addition, the planting area was overrun by pocket gophers in the first few seasons, in spite of the efforts to combat them. Help from the Biological Survey succeeded in controlling the pest, but the extent of its recondite influence on the growth of the entire group cannot be measured accurately. We must consider it as being more or less uniform.

Despite the fact that the obstacles mentioned have a restraining effect on the investigation, even a cursory examination of this pinetum vividly impresses one with its concrete value in the field of applied research. The trial probably also constitutes the earliest attempt within this section to clarify the question of seed provenance for a forest species. There are now striking regional differences in survival, height, growth, vigor and frost resistance.

In order to evaluate and compare these differences, a group-rating system is being used which does not appear incongruous considering the limited experimental controls. Under each of the four measures, Tables 1-4, the seed sources are assembled into five apposite groups for hard and fast divisions do not exist. As the four growth factors are interrelated, e. g., any influence on survival may obviously affect the other three, and as this inter-action cannot be isolated, each of the four measures is regarded as of equal importance in the general rating of development and behavior, Table 5. Therefore, the summation of group allocations roughly decides the rank or priority of individual seed sources.

The Shasta plot is considered in a place of its own on account of its outstandingly low frost resistance.

Perusing the survival rating in Table 1, we see readily that six plots fall into the uppermost group and that four of these, the Coeur d'Alene, the Bitterroot, 5,000′ elevation, the Colville and the Lolo, belong to the region bounding the experimental forest. The other two, the Helena and the Custer, are members of climates with severer extremes in temperature notwithstanding the strikingly similar annual normals, and with a mean yearly precipitation a little less than one-half though the effect of this extremely low value is ameliorated by the reception of a slightly larger amount and a better distribution of moisture during the growing season.

For obvious reasons, it must not be as-

sumed that these survival per cents allow us to create an absolute order of regional priority. They are nothing more than a fair indication in that respect.

TABLE 1.—Survival rating of western yellow pine plantations from different sources.

Rank	Source	Per cent survival 1927	Group allocation
1- 6	Helena	92	1
	Coeur d'Alene	90	
	Custer	89	
	Bitterroot, 5,000′ elev.	88	
	Colville	88	
7- 9	Black Hills	82	2
	Lolo	85	
	Umatilla	78	
	Boise	77	
10-14	San Isabel	74	3
	Whitman	74	
	Bitterroot, 4,000′ elev.	70	
	Coconino	64	
	Kaniksu	61	
15-17	Medicine Bow	56	4
	Payette	56	
	Ashley	53	
18-20	Bitterroot, 7,200′ elev.	37	5
	Siskiyou	23	
	Pecos	21	
	Shasta		

In considering height growth it was necessary to reduce the measurements to a common base of reckoning in the absence of coestablishment. As the greater number of plots had just completed their twelfth growing season, the average height growth of the remaining plots was recalculated for that period of time.

This rating, Table 2, gives us a slightly different picture than the first. Now we find that out of the four forests in group one only two, the Lolo and the Bitterroot, 4,000′ elevation, are within the west slope region of the northern Rocky Mountains. But the Helena plot is included again.

TABLE 2.—Height growth rating.

Rank	Source	Average 12-year height growth in feet	Group allocation
1- 4	Lolo	7.9	1
	Umatilla	7.7	
	Bitterroot, 4,000′ elev.	7.3	
	Helena	7.0	
5- 7	Colville	6.5	2
	Bitterroot, 5,000′ elev.	6.4	
	Coeur d'Alene	6.2	
8-14	Custer	6.0	3
	Black Hills	5.9	
	Kaniksu	5.9	
	Bitterroot, 7,200′ elev.	5.7	
	Coconino	5.7	
	Payette	5.7	
	Siskiyou	5.3	
15-18	Boise	4.9	4
	San Isabel	4.9	
	Medicine Bow	4.6	
	Whitman	4.4	
19-20	Pecos	4.0	5
	Ashley	3.2	
	Shasta		

However, present heights are not a final indication. This is apparent from changes which have occurred. For example, during the first six years of their life the Coconino trees outstripped the

TABLE 3.—Vigor rating.

Rank	Source	Rating by feeble trees		Rating of healthy trees	Total points	Group allocation
		% feeble	Points allotted	allotted Points		
1- 5	Lolo	7	6	6	12	1
	Helena	5	6	5	11	
	Bitterroot, 4,000′ elev.	6	6	5	11	
	Kaniksu	8	6	5	11	
	Coeur d'Alene	15	5	6	11	
6-10	Bitterroot, 7,200′	5	6	4	10	2
	Black Hills	5	6	4	10	
	Custer	11	5	5	10	
	Colville	12	5	5	10	
	Umatilla	15	5	4	9	
11-14	San Isabel	5	6	2	8	3
	Medicine Bow	14	5	3	8	
	Bitterroot, 5,000′ elev.	23	3	5	8	
	Payette	18	4	3	7	
15-17	Coconino	17	4	2	6	4
	Boise	32	2		6	
	Siskiyou	26	3	2	5	
18-20	Ashley	32	2	1	3	5
	Pecos	29	2	1	3	
	Whitman	46	1	1	1	2
	Shasta					

height growth of all other strains, but now they are surpassed by ten of the plots.

To provide as fair a basis as possible in ascertaining vigor, this characteristic was considered from converse viewpoints: that of the feeble trees and that of the healthy ones, as shown in Table 3. In this manner five forests fall into the highest rank. And here four, the Lolo, the Bitterroot, 4,000′ elevation, the Kaniksu and the Coeur d' Alene, belong to the climatic region of greatest interest to us. For the third time the Helena is found to be in the top order.

In Table 4 are brought together the results of a severe trial in frost resistance. On December 15, 1924, the local region experienced a precipitous drop of temperature, 57° F. in 20 hours, reaching 12° below zero. The infrigidation came on the heels of a period of rather mild weather and at a time of an abundance of soil moisture. This phenomenon was one of Nature's supreme tests. Every Shasta pine succumbed ignominiously. And the Siskiyou was barely able to maintain the representation for that region. Under such rigorous use of the law of elimination only three forests are found to be in the foremost category. And of these, the Lolo and the Bitterroot, 4,000′ elevation, are within the local clime. This time the Helena does not complete the honor roll, it is the Black Hills Forest.

TABLE 4.—Frost resistance; based on the sudden temperature drop of December 15, 1924.

Rank	Source	% of severe or fatal frost injury	Group allocation
1- 3	Lolo	0	1
	Black Hills	2.3	
	Bitterroot, 4,000′ elev.	2.8	
4- 9	Coeur d'Alene	6.0	2
	Helena	6.3	
	Colville	8.1	
	Custer	8.5	
	Bitterroot, 5,000′ elev.	10.0	
	Kaniksu	10.6	
10-17	Bitterroot, 7,200′ elev.	14.6	3
	Payette	14.8	
	San Isabel	15.0	
	Ashley	15.9	
	Boise	17.0	
	Medicine Bow	19.3	
	Whitman	19.6	
	Umatilla	20.4	
18-20	Coconino	54.4	5
	Pecos	57.8	
	Siskiyou	66.7	
21	Shasta	100.0	

A search through the available weather records indicates that physiologically significant combinations of the elements composing the phenomenon just mentioned may arise with varying intensities oftener in western Montana and the Black Hills than in either central-southeastern Montana or northern Idaho.

Evidently paramount tests do occur from time to time. They may bring to naught an otherwise promising plant introduction. Unless that introduction has undergone the decisive trial it cannot be acclaimed as weighed in the balance and not found wanting.

Having briefly examined the four evaluations singly, we shall now view them as a unit.

From the data in Table 5 we perceive without great difficulty two general divisions. They are separated geographically by a line running approxi-

TABLE 5. — General rating of development and behavior.

Rank	Source	Elevation Feet	Summation of group allocations
	Northern div		
1	Lolo	3,500	4
2	Helena	4,000	5
3- 4	Coeur d'Alene	2,500	6
	Bitterroot	4,000	6
5	Colville	2,700	
6- 9	Bitterroot	5,000	8
	Black Hills	3,750	
	Custer	3,200	
	Umatilla	3,500	
10	Kaniksu	2,500	
	Southern div.		
11-14	Bitterroot	7,200	13
	Boise	6,000	
	Payette	5,000	
	San Isabel	8,000	
15	Medicine Bow	8,000	14
16-17	Coconino	7,100	15
	Whitman	5,000	
18-19	Ashley	7,400	17
	Siskiyou	2,000	
20	Pecos	?	20
	Shasta	4,000	

mately east and west through the southern Black Hills and through the central Blue Mountains just south of the Umatilla Forest. The upper or northern division embraces the seed sources of the ten highest rated plots. All of these provenances have a striking similarity in their mean annual air temperatures, and have extremes which are comparable in a broad way. Percepitation, however, varies considerably — the yearly means as much as by one hundred per cent — so that on the whole the thermal influence appears to be the greater combining factor. It is instructive to note that thus three of the regions become an entity from which seed may be taken and used in the northern Idaho climate with more than a fair chance of impunity.

A closer examination reveals that five of the seven local seed origins form an impressive phalanx leading all others, except the trees from the Helena. The preponderance is irrefutable. But for unexplainable reasons the Helena pine takes second place while that of the Kaniksu remains in tenth place. The Bitterroot pine, descending from an elevation of 7,200 feet to that of an insignificant 2,400, is clearly out of place. It is tied with three other forests for eleventh in rank, all leading the so-called southern division. Apparently seed collected at elevations of 2,000 to 5,500 feet within the west slope region of the northern Rocky Mountains must receive the preference for local use.

The southern division is little fitted to tender its progeny for perpetuation in northern Idaho. Here even more than in the northern division temperature seems to wield a larger influence than precipitation. In general the warmer and milder climates do not produce sufficiently resistant trees for the colder district.

Despite the deficiency of the data presented in this paper, the investigation indicates at this stage that western yellow pine native to the general region of the plantation has every advantage over trees from a different climate.

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Inheritance of Growth Habit in Winter and Spring Wheat Hybrids

E. F. GAINES

INTRODUCTION

Winter wheat is popularly understood to be any wheat that is sown in the fall of the year, ranging from August to December. Spring wheat, on the other hand, is that sown in the spring of the year between February and June. The material in this paper, however, puts a slightly different interpretation on spring and winter wheats. As it will be used in the following pages, winter wheat is one that will not head out or develop seed when planted in the spring. The spring wheat will head out when planted in the spring, but will generally freeze out if sown in the fall.

Sometimes it is desirable to cross spring and winter varieties in order to combine certain characters. To do this it is of advantage to understand how the spring or winter habit of growth is inherited. It is necessary to know the manner in which the segregates of such a cross are distributed, and whether it is possible to obtain new varieties from such a cross that will ripen earlier, just as early, or later than the spring parent. These are important factors in sections of the country where disease, insects, or drouth are to be combated. In most of our dry-land areas early-maturing wheats are desired in order that the crop may escape the hot weather and mature its seed before the moisture is exhausted. In other districts ravages of insects are avoided by growing early-maturing varieties; in still other localities early varieties are sown because of their ability to escape destruction by stem rust. In the higher altitudes of the Pacific Coast region, on the other hand, later maturing varieties which will utilize a longer growing season will produce a larger yield than those that ripen early. Comparative winter hardiness is of great economic importance in areas where frost injury is a vital factor. It is seen therefore that the economic aspects of the manner of inheritance of growth habit is sufficient to justify such research without considering the scientific knowledge that may be gained.

This is not an entirely new field, as other investigators have worked on the problem. Among the different workers there has been considerable variation as to results obtained. The problem has three phases: (a) behavior of the progeny of spring and winter crosses; (b) the inheritance of earliness in crosses between two spring wheats; (c) the climatic factors involved which determine whether a plant shall be spring or winter, early or late.

Review of Literature

Spring habit of growth has been found to be inherited according to Mendelian ratios, but all investigators do not agree as to the number of factors involved. Spillman (7) reported a dominance of *"winter"* in his crosses in which he obtained a ratio of 3 winter to 1 spring segregation in the F_2 generation. Later the writer (5) in crossing two spring barleys obtained a ratio of 81 spring forms to 19 winter. The F_1 generation had matured from spring sowing. This ratio of 13:3 was obtained in 2 different crosses, Excelsior X Rice and Beardless X Rice. Thus spring habit in these particular crosses resulted from the interaction of two factors with winter habit recessive for one and dominant for the other.

Vavilov and Kuznetsova (11) obtained a ratio of 16 spring to 1 winter in a cross between winter and spring varieties. Their experiment included 552 F_2 plants, 500 of which were early or late spring forms. Of the 500 F_3 families grown from the F_2 spring plants, 234 proved to be constant spring types, of which 36 gave only late spring plants and 266 segregated into spring and winter plants, totalling 9551 spring and 2191 winter. They also crossed two spring barleys which gave rise in the F_2 generation to 47 spring types, 2 intermediates, and 10 typical winter forms. In another cross 7 winter forms were obtained in an F_2 population of 86 plants. These results suggest the di-hybrid ratio of 13 spring to 3 winter forms similar to the barley hybrids of the author described earlier.

In 1923, Aamodt (1) reported on the inheritance of growth habit of a cross between Marquis (spring) and Kanred (winter). He interpreted the results on the basis of Mendelian factors but concluded from the wide genetic variability which the different segregates of spring habit showed that multiple factors were involved. He obtained homozygous segregates that headed 5 weeks later than that of the Marquis parent. Apparently there was no linkage between growth habit and awns or resistance to stem rust.

Cooper (2a) also studied the genetics of spring and winter habit in crosses between spring and winter wheats. In most of his crosses the segregation resembled a di-hybrid, giving a ratio of 13 spring to 3 winter type. He also made crosses of spring and winter wheats which segregated in the ratio of approximately 3:1. He called attention to the long vegetative period of the winter type.

Gaines and Singleton (6) analyzed a cross between Marquis and Turkey. The ratio of spring to winter plants was 35:1 in the F_2 population and 7:1 in the F_3. This not only indicates the partial dominance of spring habit but also that the inheritance of winter habit is controlled by multiple factors. They also found no linkage between habit of growth and resistance to stinking smut. Summarizing the previous work with crosses between winter and spring habit, these segregates are definately heritable but may be induced by one, two, or more factors acting independently.

Crosses made between two spring wheats which vary in time of ripening may be of interest. Thompson (8, 9, 10) has made a very extensive study of this point. In 1918 he reported the results of a cross between extremely early and extremely late ripening spring wheats. The F_1 matured with the late parent. The F_2 plants formed regular curves of probability with intermediate means, in most cases the variantion extending from below the mean of the late parent to above the mean of the early parent. In testing his hybrid segregates in the third, fourth and fifth generations he concluded that the inheritance of the ripening date to be controlled by multiple factors in which individuals earlier and later than the original parents might sometimes be obtained.

The work of Florell (4) with Marquis X Sunset gave a ratio of approximately 3 early to 1 late. He believed it possible to determine progeny rows homozygous for earliness in the F_3 generation by the time required to pass through the heading stage.

Wanser (12) has done preliminary work which indicates that the amount of light received is the key to the situation. The length of daylight under given conditions of moisture and temperature has a profound effect on the heading and maturing of the wheat plant. Various wheats respond to the amount of light received in an entirely different manner.

Dickson (3) has done some interesting work on the effect of low temperatures

on wheat. At 24° C., Turkey wheat tillered profusely but did not joint, while at 20° or lower the plants headed and ripened in normal season.

The work with light, temperature, and moisture opens a field for fundamental research which may give valuable information on the hereditary complex of the growth habit in wheat.

Methods

A comprehensive study of the inheritance of growth habit in various wheats of the Pacific Northwest was undertaken by L. R. Powers for his Master's thesis from 1924 to 1926. Eleven different crosses between spring and winter wheats were available at the Washington Experiment Station at Pullman, including the spring varieties, Marquis, Florence, Velvet Node, Jenkin, Jumbuck, and Sonora. The winter varieties used were Ruddy, Hussar, Hybrid 128, Red Russian, Selection C, Fortyfold, and Turkey. The F_1 seed was divided into three equal lots, each lot being planted on a different date, February 28, April 4, and May 4th. Each of the parents were also planted on the same three dates. One cross, that of Hybrid 128 X Velvet Node, had been made earlier and an F_2 population of 393 plants was available for determining the inheritance in the F_3 generation. The F1 material of this cross had been sown in the fall, and fortunately a mild winter allowed the maturity of both spring and winter plants in normal ratios. Owing to the small quantity of seed, but one date of planting was used for this third generation, the material being sown on April 4, 7, and 8.

All F_2 hybrids and parent material sown on February 28 headed and ripened normally as if it had been fall sown. The second date of sowing showed one type of segregation and that sown May 4 showed an entirely different type of segregation.

The date of ripening was chosen as the means of separating the spring and winter progeny. A plant was considered ripe and was harvested when the outer glumes and the visible part of the inner glumes as well as the base of the rachis of the tallest clum had turned yellow. In handling the results statistically the ripening periods were divided into weekly intervals. The first period was from July 22 to 27. From then on at the end of each week the ripened plants were pulled and the tallest culm of each plant collected for further study. The harvesting extended over eight weeks. On September 24 all the remaining plants were pulled and divided into three groups, ripe, just headed, and those not headed. The periods of ripening numbered from 1 to 8. The plants that were headed on September 24 but not ripe were put in the 9th period and those not yet headed were considered as true winter plants and went into class 10. There is necessarily some experimental error in such a volume of work, as the rows harvested earlier in the week would not contain as many ripe plants as those harvested later in the week. By harvesting in the same order each week, however, the error would be recompensed by a larger number the following period.

Reaction of Parents

All parents, both winter and spring, planted February 28 ripened on the first period, that is, they were all ripe by July 27. This would indicate that the climatic conditions to which the varieties were exposed at this time of planting produced the same response from the winter as from the spring factors of growth habit.

Those planted approximately a month later showed great variation. The spring parents still ripened uniformly on the first period but the winter parents could be divided into three distinct classes: the *first* class included Fortyfold and Hybrid 128, neither of which ripened nor headed any plants during the entire summer;

Ruddy, Hussar, and Red Russian composed the *second* class, of which Ruddy and Hussar ripened one plant on the seventh period and were one-third headed on the eighth period, while Red Russian had one plant ripe and one-fourth of the plants had headed when pulled; the *third* class consisted of Selection C and Turkey, both of which ripened plants on the fifth period and from that time on until harvested, at which time three-fourths of the plants were headed.

The parent rows sown May 4 showed greater variation among the spring varieties and less variation among the winter varieties. The spring varieties may be divided into three classes: *first*, Florence, which was ripe at the end of the second period, August 3; *second,* Marquis, Velvet Node and Jumbuck ripe at the end of the third period, and *third,* Jenkin and Sonora which ripened during the fourth period, August 17. The winter varieties were classified into two groups. Selection C and Turkey began heading during the fifth period. The others failed to head.

It should be noted that after the middle of August wheat does not ripen normally. For example Turkey planted April 4 ripened the plants from August 24 to September 14, but the plants exhibited such abnormalities as shortened internodes, sterility, and a great excess of vegetative growth.

F_2 Generation

The segregates of all the crosses planted February 28 ripened on the first period. Those planted on April 4 showed a difference between crosses in their manner of segregation. It was possible to group the crosses into three classes: (a) Turkey X Jumbuck, Jenkin X Turkey, and Marquis X Turkey. These did not produce any winter plants. Since there were as many as 125 plants in the Turkey-Jumbuck cross, it seems that more than three factors for spring habit were involved. (b) Hybrid 128 X Velvet Node, Sonora X Fortyfold, Marquis X Ruddy, and Red Russian X Marquis. The percentages of winter plants in these crosses were 2.7, 2.8, 3.3, and 4.4, respectively, which is higher than would be expected for a trihybrid. The expected is 1.6 per cent. (c) Hybrid 128 X Jenkin, Turkey X Florence, Hussar X Florence, Selection C X Jenkin. The percentages of the winter segregates were 5.7, 5.7, 6.1, and 7.0, respectively, which approximates very closely the 6.25 per cent expected in a dihybrid. Crosses in this class then segregated on the basis of a two factor difference. The means of (b) suggest a partial dominance of some of the factors for spring habit. The reaction from the planting April 4 is given thus in detail because this is the approximate date that spring sowing becomes general, and is the date that produces maximum yields of spring wheat. The one cross, Hybrid 128 X Velvet Node, was tested in the third generation to prove whether a three factor interpretation for the April planting would hold. Without going into the statistical data, which would be too voluminous for this paper, it may be said that this third generation proved the correctness of the trihybrid hypothesis in a very striking way. Six of the F_3 families failed to head out, thus proving one plant in 64 to be homozygous for the triple winter recessive. The three factors A, B, and C. were not of equal value, however. Any plant possessing the A factor would ripen during July and of course, those containing A and B, or A, B, and C would also ripen during July. In the absence of A and C, B would cause the plants to ripen from the 10th to the 20th of August. C acting alone in the absence of A and B would cause the plants to ripen from the 20th of August to the first of September. In the case of C, however, there is a partial reversal of dominance,

so that unless an F_3 family were homozygous for C, the row would contain a majority of winter plants. This is a rather complicated assumption, but once it is understood it fits beautifully the results obtained.

If the planting had been done a week earlier or a week later, there would have been a corresponding shifting and a different type of segregation would have been obtained. The results show that we are dealing with a moving mean which changes with the season, being affected primarily by changes in temperature and the length of daylight in 24 hours. There are at least 4 different factors concerned in the material we are working with. One cannot tell for sure what factors a given variety of spring wheat possess by its date of heading or maturity. This explains some of the apparent contradictions to be found in the literature and may account for some of the heretofore puzzling phenomena in growth reactions of other crops.

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Recent Developments In Suspension Bridge Design

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The past six years have seen the inception and completion of several notable suspension bridges, involving, so far as American practice is concerned, several interesting innovations. The purpose of this paper is to describe several of these structures and to discuss in some detail the conspicuous departures from current practice.

The Delaware River Bridge

The Delaware River Bridge (1) extends between Philadelphia, Pennsylvania, and Camden, New Jersey, a total distance of 1.8 miles. The main span stretches a distance of 1750 feet center to center of piers and a clear distance of 1690 feet between pier lines. The side spans are 716 feet 8 inches each. The bridge has a clearance above high-water of 135 feet for a distance of 800 feet, or 400 feet each side of the center of the bridge. The length of this span becomes notable when compared with existing structures. The Brooklyn Bridge has a span of 1595 feet 6 inches; the Williamsburg Bridge, for many years, boasted the longest suspension span in existence, a length of 1600 feet; the Bear Mountain-Hudson River Bridge, a highway structure with a single roadway, has a span of 1632 feet. The Board of Engineers employed to make recommendations concerning the type of span, recommended that the suspension type be employed rather than the cantilever for two reasons: First, the former gave a better appearance and could be erected at a less cost; and second, the superstructure of the suspension bridge could be erected in less time since the work was capable of division into several contracts which might be let separately as the money became available. A year's time in erection, it is estimated, was saved in this manner.

The cross section of the bridge provides for a six-lane roadway, in addition to which there are four track spaces and two footways. The distance between curbs is 57 feet. Two cables are used and two stiffening trusses. The use of two stiffening trusses has certain advantages, since this type of construction provides two points of support fo: the floor beams. As a result there is no straining in the floor system due to unequal deflection of the stiffening trusses. Furthermore, the two-cable system contributes to economy in the towers, in the width of bridge, in the anchorages and in the cable itself.

The cables in this bridge are the largest in the world and represent an increase of 50 per cent in diameter and 100 per cent in cross section area over the largest previously existing ones. This distance center to center of cables is 89 feet.

Another unusual feature in this design is the elimination of over-head lateral bracing.

For the purpose of preliminary design, is was asumed that the maximum possible live load that could be crowded on the bridge would amount to 12,000 lbs. per lineal foot. Of this amount, one-half was taken as the working live load. Since this load of 6,000 lbs. per lineal foot would occur infrequently, higher stresses were permitted. The total actual dead load amounts to 23,200 lbs. per lineal foot on the main span and 24,000 on the side spans.

The nests of rollers which were placed under the cable saddles of the Brooklyn Bridge were found to be inoperative. The same conditions existed in the Williamsburg Bridge whose towers were of steel, not masonry, the material used in the construction of the towers of the Brooklyn Bridge. As the result of these experiences, it was decided to build the towers of the Delaware Bridge of steel and to so design them that they would bend the required amount, thus doing away with the necessity of rollers.

The results of numerous tests of the cable wire were embodied in the specifications which called for a minimum ultimate strength of 250,000 lbs. per square inch and a yield point of not less than 144,000 lbs. per square inch, with an elongation of not less than 4 per cent in 10 inches. Tests on full sized strands, a strand contained 306 wires, gave an efficiency of 94 per cent; that is, a strand would withstand 94 per cent of the stress which 306 individual wires would withstand. Sixty-one strands were required to form each one of the 30-inch cables; a sum of 18,666 wires in each cable.

The Florianapolis Bridge

This structure is located in the State of Santa Catharina, Brazil (2). It has a main span of approximately 340 meters and is chiefly notable for the type of stiffening truss employed, and for the use of rocker towers. The cables of this bridge are made of high-tensioned, heat-treated eye-bars. In the central part of the bridge the cable is in tension, of course, while the upper chord of stifffening truss is in compression. "By combining the two opposing structural elements, one member is made to take the place of two." The maximum bending moment in a suspension-bridge stiffening truss comes near the quarter point. For greatest efficiency the maximum depth of truss should also be at these points. Therefore, reasons Mr. D. B. Steinman, parallel chords in stiffening trusses are not economical. "The most serious deflection of a stiffening truss, as measured by the resulting deflection gradients, is produced under the condition of live load covering one-half the span. Half span loading produces a downward deflection of the loaded segment and a smaller upward deflection of the unloaded segment, with a maximum deflection gradient at the loaded end." The stiffening trusses of the Floriniapolis Bridge are of varying depth with a maximum near the quarter points of the span. In this bridge, the gain of rigidity was such (about 300 per cent) that the maximum deflection under full span loading was only 1.88 feet, or 1/592 of the span; under half span loading the deflection was 1.36 or 1/820 of the span length.

The steel used in the manufacture of the heat-treated eye-bars was developed by the American Bridge Company. The material used is a carbon steel, although the amount of carbon is higher than in ordinary structural material. An elastic limit of 75,000 lbs. and an ultimate strength of 105,000 lbs. per square inch were specified, thus providing for a working stress of 50,000 lbs. per square inch. The guaranteed minimum elongation was 5 per cent in 18 feet. The bars are 12 inches wide and vary from 1-3/8 to 2 inches in thickness.

This bridge is designed to take a railway loading of a 50-ton electric locomotive, followed by 2,000 lbs. per lineal foot, plus 50 per cent for impact; a highway loading of a 6-ton motor truck, or 60 lbs. per square foot with 25 per cent for impact; and a sidewalk loading of 60 lbs. per square foot. The dead load for which the main span was designed, amounted to 4,370 lbs. per lineal foot. The live load assumed in the design of the main span was 2,000 lbs. per lineal foot, plus 10 per cent for impact. A

wind load of 25 lbs. per square foot was assumed on the main span.

The towers of this bridge are 230 feet high and have battered legs; the width at the base is 55 feet 6 inches and at the top 33 feet 6 inches. A rocker casting attached at the base of each column has a surface finished to a radius of 12 feet. During the period of construction the column is held fixedly in place.

The General U. S. Grant Bridge

The General U. S. Grant Bridge is located over the Ohio River between Portsmouth, Ohio and Fullerton, Kentucky (3). The features of unusual interest in this structure are the continuous stiffening trusses, rocker towers, rocker bents supporting the cables, and sand filled anchorages. In addition to these structural features, the method of spinning and placing the cables is of especial interest. The bridge has a center span of 700 feet and two side spans of 350 feet each. The sag of the main cable is 70 feet or 1/10 of the span. The main towers are 118 feet in height.

The bridge was designed to ultimately carry three lanes of traffic on a width of 28 feet between curbs and a 6-foot sidewalk outside brackets. The loads employed in the design were as follows: For the floor system—a maximum load of a 20-ton truck at any point, or a normal load of three 15-ton trucks abreast, plus an impact allowance of 37½ per cent for the stringers and 30 per cent for the floor beams; for the stiffening trusses, cables, towers, and anchorages—a uniform live load of 1400 lbs. per lineal foot plus a superimposed concentrated load of 42,000 lbs. at any point. The uniform load represents 50 lbs. per square foot, a loading due to three lanes of traffic. "The concentrated load represents the excess weight of three 15-ton trucks abreast at any point in this system of traffic."

An estimated load of 1,748 lbs. per lineal foot was used in all calculations. The wind load employed was 30 lbs. per square foot on 1½ times the vertical projection of the structure and a temperature variation of +60° F. was assumed.

For the first time in this country rocker towers were employed. In South America the Florianapolis Bridge designed by the same firm, employed this innovation. The designers claim that a substantial saving in the material of the main tower is effected since bending seress is eliminated. Also, there is a saving in the pedestals at the base and in the substructure. The basic unit stress employed is 18,000 lbs. per square inch, which, when reduced by the column formula and increased 25 per cent for the inclusion of wind stress, gives a permissable stress of 17,700 lbs. per square inch.

The rocker bents maintain the cables in the proper position vertically and sustain the reversible end reactions of the continuous stiffening trusses; also, they carry the end reactions of the approach girder spans. These bents possess the ability to rock, just the same as the main towers do. They are placed at each end of the suspension structure to support the cables which are anchored some 150 feet away from the bents.

In the manufacture of the two cables used in this bridge, a No. 8 wire, 0.162 inches in diameter was used instead of the conventional No. 6 wire which is 0.192 inches in diameter. The lighter wire was used to avoid anticipated difficulties from stiffness during air stringing. Each cable was made of three strands of wire and each strand was composed of 486 individual wires producing 30 square inches of cross-section and a diameter of 7-1/8 inches after squeezing. The cables were wrapped with a No. 9 soft-annealed double-galvanized wire; a machine the invention

of Mr. H. D. Robinson, one of the designing engineers, was employed for this operation.

The specifications governing the cable wire, call for a minimum yield point of 140,000 and an ultimate strength of 220,000 lbs. per square inch. The initial condition of the bridge calls for a working stress of 70,000 lbs. while a future condition may call for 80,000 lbs. per square inch in the cables. At present, the roadway is only 22 feet wide and the footwalk is inside the trusses. At some future date the roadway will probbaly be widened to 28 feet and the walk placed on brackets outside the trusses.

Differing from conventional practice the suspenders of this bridge were made non-adjustable. This condition calls for an exact calculation and careful measurement in cutting and socketing.

In place of galvanized wire, bright wire was adopted for use in this bridge. It has a lower cost and a greater strength. An examination of Roeblings' Niagara Bridge shows that after fifty years of use, the bright wire in the structure is in good condition. Although air stringing had been expected in the construction of the General Grant Bridge, individual strands of the cable were strung on the ground and thus finished before the towers and anchorages were completed. A railroad siding 1800 feet long was the site of this operation; a gasoline track car was used to string the wires. This method is not new, having been developed along the Ohio River many years ago. However, some trouble was experienced with the strands coiling after they were loosened but this was remedied.

Bear Mountain-Hudson River Bridge

This bridge is located 42 miles above New York City (4) and at a point where it is said that in 1779 the Continental Army stretched "huge chains across the river to prevent the British fleet from passing up the river to attack West Point." It has a span of 1632 feet and is of the two-cable type. The back stays are unloaded and therefore straight. The clearance at high tide and at the center of the span in 155 feet.

The floor system of the bridge is designed to carry 15 and 20 ton trucks. A load of 70 lbs. per square foot was specified for the live load on the main span and this is equivalent to a total of 216 10-ton trucks, or four lines of 54 trucks each. The roadway is 38 feet wide and on each side of it there is a 5-foot side-walk. The stiffening trusses were designed to carry the live load of 3,160 lbs. per lineal foot and the material of which they are composed has a specified ultimate strength of not less than 80,000 lbs. per square inch. These trusses have a depth of 30 feet, are spaced 55 feet apart, and carry the floor of the bridge upon the upper chord. They have a camber of 15 feet in order to meet the War Department clearance requirement.

The towers are of structural steel and are designed to take bending stresses, thus compensating, without the use of movable saddles, for the movement of the cables due to live load stretch or temperature. The towers are 350 feet high, 89 feet 10 inches wide at the base, and 61 feet 4 inches wide at the top. The saddles, at the top of the towers, were not rigidly bolted until after the completion of the superstructure. The rollers beneath the saddles were then fixed by the use of metal cement.

Each main cable of this bridge is composed of 37 strands and each strand contains 196 wires. This gives a total of 7.252 wires in each cable and a diameter after squeezing and wrapping of 18 inches. The strength of this structural member is approximately 23,600 tons. The wire used was No. 6, having a dia-

meter of 0.192, before galvanizing and a diameter of 0.195 inches after the galvanizing process. "Under the old method of construction, the strands when finished were bound together at intervals through the entire length of strands by bands of round serving wires. When a sufficient number of strands were completed, seven of the strands in the middle of the cable were bound together to form a central core and all of the above mentioned round wire servings were removed from the individual strands. After the central core was completed, the next outer layer of 12 strands was formed around this core in a similar manner, and each successive layer was formed around these as a core until the cable was completed. The squeezing jacks were then applied and the cable was completed to its finished diameter. This, it will be observed, was a slow and tedious procedure." In the Bear Mountain Bridge for the first time, flat wire bands replaced the round serving wires and these bands were left in the finished cable. This practice did away with the necessity of forming the central core and successive outer layers and permitted the cables to be finished in one operation.

Resume

The Delaware River Bridge possesses the longest span of any suspension bridge in the world; also, its cables are record-breakers, each having a diameter of 30 inches. The stiffening trusses of this bridge are not braced in the plane of the upper chord. The towers are designed to take bending moment stress obviating the necessity for movable cable saddles. The total cost of this structure amounts to $36,023,373 of which $24,574,024 represented the construction cost and $11,449,349 were paid for real estate.

Regardless of who first conceived the idea, to the Florianapolis Bridge must go the credit of being the first suspension bridge, actually constructed, in which the cable is also the top chord of the stiffening truss. Also, this bridge is remarkable in that for the first time rocker towers were used in the Western hemisphere. The heat-treated eye-bars developed by the American Bridge Company and employed in this structure, mark a distinct advancement in the manufacture of bridge steel. The form of the truss, deep at the quarter-points, where the bending stress is a maximum, is also a peculiarity of this bridge.

The unusual features of the General U. S. Grant Bridge are: Continuous stiffening trusses, rocker towers, rocker bents, and sand filled anchorages. The continuous stiffening truss is a new development. The rocker bent appears here for the first time. A novel construction feature, although not a new one, was the method of stringing the wire strands on land. The designers of this bridge adopted non-adjustable suspenders.

The Bear Mountain-Hudson River Bridge is noted for its long span, for its towers, designed to take bending stress, and for the height of these towers. This is a highway toll bridge.

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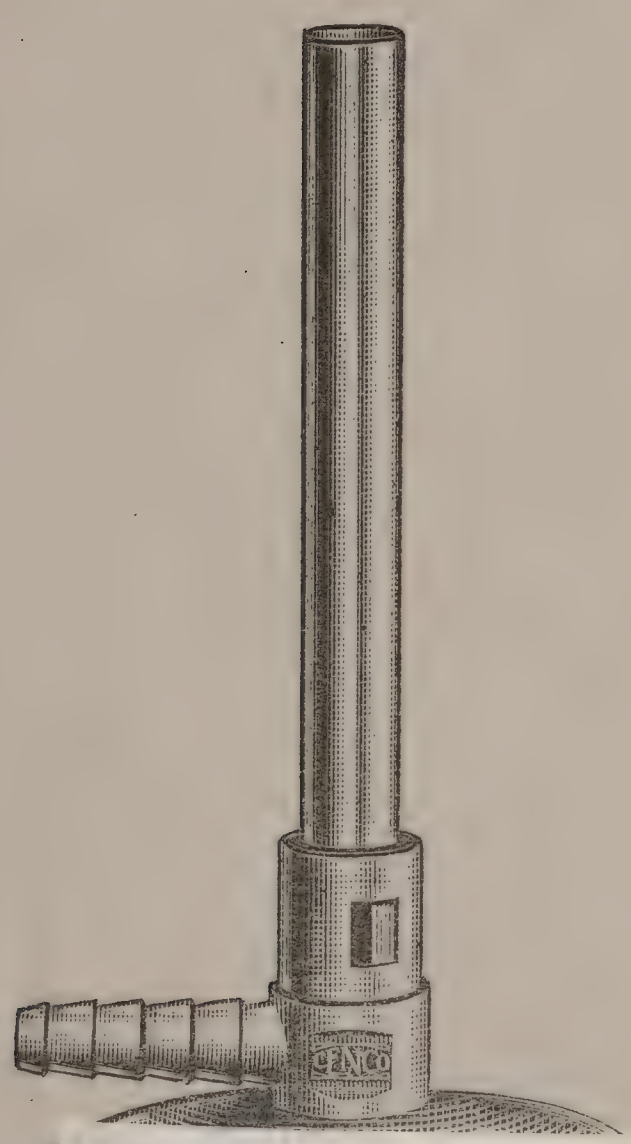

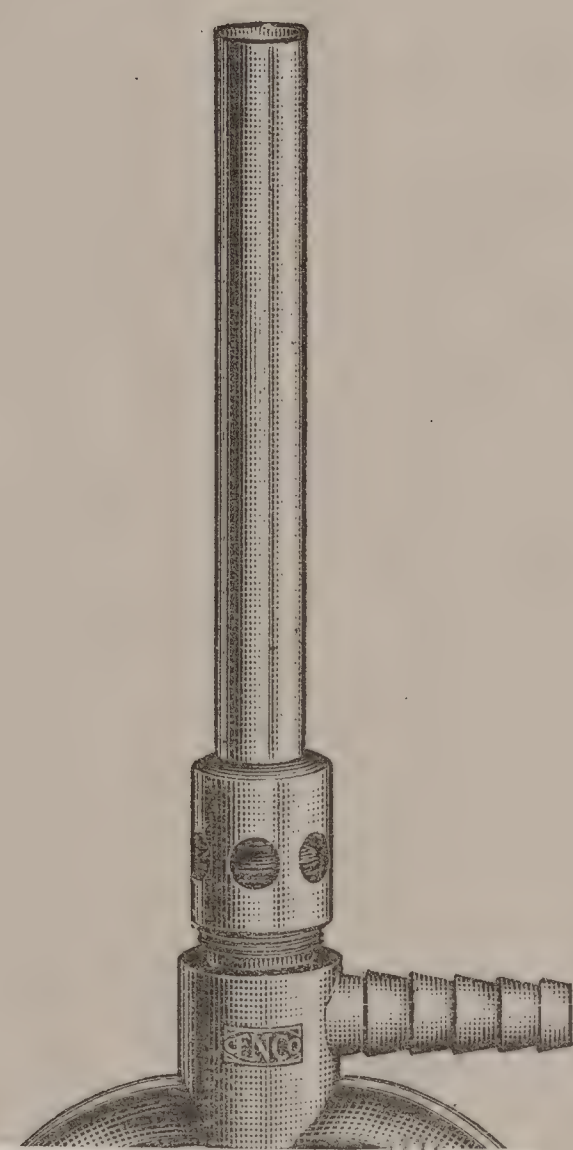

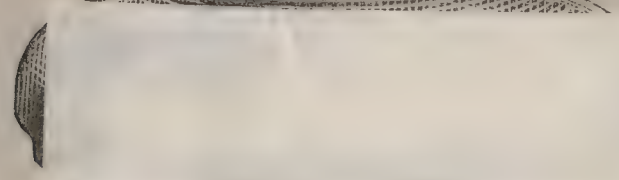

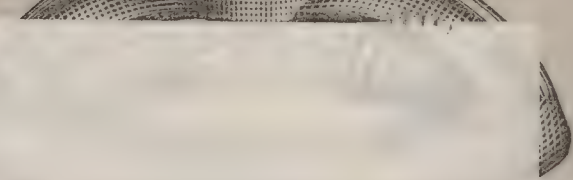

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Joseph Edward Kirkwood

(January 24, 1872—August 16, 1928)

Address at the funeral services held in Missoula

By President Charles H. Clapp

Dr. Joseph Edward Kirkwood was born in Cedar Rapids, Iowa, January 24, 1872. His father, Robert, was a son of a Scotch emigrant and with his father, Dr. Kirkwood's grandfather, served with the Union forces throughout the Civil War. His mother, Phoebe Hough, was of English and German ancestry. Joseph Edward was the oldest son and when he was twelve, in 1884, the family, consisting of the father and mother, two sons and two daughters, moved to Oregon, literally to carve out a farm in the timbered wilderness in the upper part of the Willamette valley. Here on the farm Joseph Edward worked eight years when the father sent him off to school for an education.

Those of us who knew him well can readily imagine the tall, husky youth of sterling quality and unwavering purpose, who was hailed with delight by his fellow students, who soon learned not to call him a country gauk, as he became the flying center for their football team. In six years he had finished his preparatory work and college at Tualatin Academy and Pacific University.

It was then that he developed his deep interest in botany and the high standard of performance and scholarship which has been one of his outstanding characteristics for the rest of his life. A private fellowship made it possible to begin graduate work at Princeton, and an assistantship continued the graduate study for a second year at Columbia.

He brought his bride, Ella Belinda Hoyt, from Oregon to Syracuse University in 1901 when he began teaching as an instructor in botany. In spite of a meager salary they saved enough to pay his college debts and to continue his graduate work at Princeton and Columbia. He earned his master's degree from Princeton in 1902 and his doctor's degree from Columbia in 1903. His three children were all born while he was at Syracuse University where he rose to become professor and chairman of the department of Botany.

The next two years, 1907 to 1909, were spent in the desert region of Mexico and Arizona, the first year as botanist for a rubber company studying the possibility of cultivating commercially the Guayule shrub as a source of rubber and the second year as research worker with the Carnegie Desert Laboratory at Tucson.

Dr. Kirkwood took up his work with the State University of Montana in the fall of 1909, first as professor of botany and forestry, and later in 1914 as professor of botany and chairman of the newly organized department of botany.

Here in the northern Rocky Mountains he found a struggling university which he has helped to build, and a great interest in the diversified flora, from the microscopic organisms of Flathead lake to the towering yellow pines of the valleys and lower mountains. He has been an untiring worker for his department, his university, and his science. He has collected thousands of specimens of plants and has built a priceless herbarium representing the flora of this region. He has described the flora in numerous publications, notably a bulletin, "Forest Distribution in the Northern Rocky Mountains", written at the University of California during his habbatical year 1919-1920 and published by the University in 1922, and a book, still in manuscript, "Trees and Shrubs of the Northern Rocky Mountains" which, it is to be hoped, the University will publish immediately as a memorial volume.

He served the University as a whole chiefly as a member of the Research Committee, chairman of the Scholarship Committee, and chairman of the Graduate Committee. He has stood uncompromisingly for the highest standards of scholarship and conduct, and his influence has been great. No small share of the recognition which has been gained by the State University of Montana is due to his efforts.

Of late years he has been interested in spreading an appreciation of science and scientific methods. He has studied critically and constructively the presentation of science in the high schools of the Inland Empire and has assisted greatly in its improvement. He has been a leader in the Northwest Scientific Association, generously contributing his time and money in working out an inclusive and stimulating program for the promotion of science in the Northwest. In most of his writing he has had in mind the general reader, and has used, to quote his own words, "a non-technical style as far as consistant with dignity and accuracy."

This phrase, "dignity and accuracy" perhaps characterize Dr. Kirkwood better than any other two words, but they give no idea of his youthful, vigorous, enthusiastic mind, his artistry which characterized even his technical drawings, his subdued sense of humor which came to the top in the intimacy of field and camp, and his boyish kindliness and lovableness.

He has said that this last summer spent in studying the microscopic plants of Flathead lake in company with his brother scientists was the happiest he has ever had, and we can take comfort in that.

Our loss is great and will be felt deeply not only by the students and faculty of the State University but throughout the Northwest; but even in his death he seems to have taken care of things so that we who are left behind can carry on, and his example will make it our duty to do so.

It has been a great satisfaction to have known him and to have worked with him. Our deepest sympathy is with his family, but even that is tempered by the knowledge of the great satisfaction and happiness that they have had, and will never lose, in living with a man of his sterling character.

Natural Resources and International Problems*

(Abstract of President's Address)

CHARLES H. CLAPP

Retiring President, Northwest Scientific Association, President, State University of Montana

Nature is not only the source of all energy, but through the mental and physical work of man the source of all wealth, and hence like money "the source of all evil". At least Nature and Nature's resources are at the bottom of a lot of man's troubles, especially those which have to do with his international relations. In spite of the sincere efforts of wise, courageous and sympathetic men to alleviate these troubles there has been little attempt on the part of anyone to solve the difficulties by the method which has proved so successful in turning natural resources into money. There is not the same "facing the facts" or desire to discover "changeless natural laws" as a basis of choice. Instead ambition, custom, or prejudice seem to have been the basis of choice.

Through the world's failure to observe natural laws many of Nature's resources, which might have been waxing resources, are waning. As a result there has been almost continuous search and strife for new and virgin territory, a "place under the sun"; an attempt to make each nation "self-contained." If the same thought and energy thus expended had been applied to a more efficient use of resources already known, in many instances the return would have been greater than that obtained from the virgin territory.

Many resources are capable of being transplanted from one country to another, from one region to another, even from one climate to another. Some however defy transplanting. Certain plants grow only in the tropics. Grain does best in sub-polar regions with long hours of sunshine. Domestic animals find it difficult to survive in the wilderness and game does not flourish in the midst of cultivated districts. The supplies of minerals, except as they have been depleted by man are still as Nature distributed them. These resources thus securely wedded to their native lands are the cause of many international squabbles.

Everyone is interested in the efficient use of the world's resources, in their discovery, development, and utilization, and in minimizing the difficulties resulting from their unchangeable geographic distribution. There is no intelligent, broadly, self-interested person, party, nation or league of nations but wants solution according to sound principles drawn from facts. Here is the great opportunity to extend the scientific method into wider fields.

No nation not even the United States with its great area and widely diversified geology and climate can stand alone. Neither can the British Commonwealth of Nations.

Some resources,—building materials, water, soils, and domestic animals, are widely and fairly uniformly distributed, and do not cause international difficulties. It is the highly concentrated resources,—potash, nickel, rubber, spices, and fur seals, which do. But even many of the common resources, such as copper, iron, coal, oil, grain, cotton, timber, and

*For further and more detailed information concerning this topic see International Control of Minerals, Mining and Metallurgical Society of America and American Institute of Mining and Metallurgical Engineers, New York 1925 and C. K. Leith "Exploration and World Progress" Foreign Affairs, October, 1927; pp. 128-139.

sheep are controlled by three or four nations and the rest of the world's nations, deficient in these resources, are dependent.

The development of these resources has been left largely to private initiative and enterprise, and until recently their production and utilization conformed essentially to the normal trade law of supply and demand. In part the natural movement was affected even if not controlled, by bonuses, embargoes, tariffs, patents, monopolies, and trade and transport controls. These normal conditions were greatly changed by the Great War. Since the war the problems have become both acute and confused because of improved methods of transportation; because of recognition of the inter-dependence of all nations and of the necessity to use the world's resources for the benefit of the world; and especially because of the identification of governments with private enterprise, and the attempt where cleverly possible to "close the door" to the private enterprise of other nationals through actual government ownership, transport control, nationalization of resources, high tariff walls, and mandates. Thus a new dilemma, government control and the closed door or international control and the open door is presented.

With the idea of lessening friction, of insuring equality of opportunity to all nations, and of protecting the interests of all people, new instruments such as international fact-finding commissions and international trusts or trade cartels have been devised.

Already certain principles have been emerging:—important among others, the principle that for maximum use or true conservation of natural resources specialization of effort is necessary; and the principle that the open door should be maintained even in backward countries, provided that the method of keeping the door open is human and insures a fair deal to all concerned.

The United States as the world's largest exporter has the largest issue at stake in any scheme of control and her citizens should not view the problems as local or national, because willy-nilly they are economically entangled. As with most dilemmas the national and international aspects only appear to be opposed and science, business, and the "new diplomacy" must find a way to synthesize the valuable points of each aspect. Facts, brought to the surface by pooling information, and a policy of enlightened self interest will go a long way in eliminating long delays, unnecessary handicaps to maximum use, misunderstandings incident iron, coal, oil, grain, cotton, timber, and causes of war.

Only a generation ago we feared the increasing size of trade units in this country. Today we foster big business as more efficient and more easily subject to government control. Today the increasing size of the trade units of the world must lead to international control, and we need not fear them merely because they are big and international, unless we ourselves are not big enough and international enough to be a party to the control.

An Annotated Catalogue of the Vascular Plants of Benton County, Washington*

HAROLD ST. JOHN and GEORGE NEVILLE JONES

Introduction

This is the first attempt to enumerate the species and varieties of vascular plants which grow without cultivation in Benton County, Washington. Nothing has been published on the vegetation of this region since the appearance of Piper's excellent work, "Flora of the State of Washington," in 1906 (1). Increased knowledge of the flora of this region, and the changes brought about by irrigation and grazing since that time, would seem to justify a summary of the information now available.

The following catalogue is based chiefly on the collections made by the writers in the summer of 1926 and in the spring of 1927, and on the extensive collections made by Mr. J. S. Cotton in this region in 1901 and 1902. Miss Ruth L. Bennett of Prosser has very kindly loaned her collection from that vicinity. Others have collected in the county at various times and their names appear in association with the specimens which they collected. Plants listed as having been reported from a given place have been included on the basis of plants which have been sent to the Botany Department of the State College from time to time by various persons for identification. Most of the specimens upon which this list is based are in the Herbarium of the State College of Washington at Pullman.

The Bryophyta and Thallophyta, which are not as abundant in the dry areas of eastern Washington as in the moister wooded regions farther west, have been omitted from the list, chiefly because of lack of knowledge. This is to be regretted as these plants are of great ecological importance.

As the flora of a region is not a definite or fixed quantity, it is not to be supposed that the present catalogue is complete. It is possible, also, that there are a number of plants growing in the county that have escaped the attention of col-

*Contribution from the Department of Botany, State College of Washington, No. 9.

1. Contrib. U. S. Nat. Herb. 11:1-637. 1906.

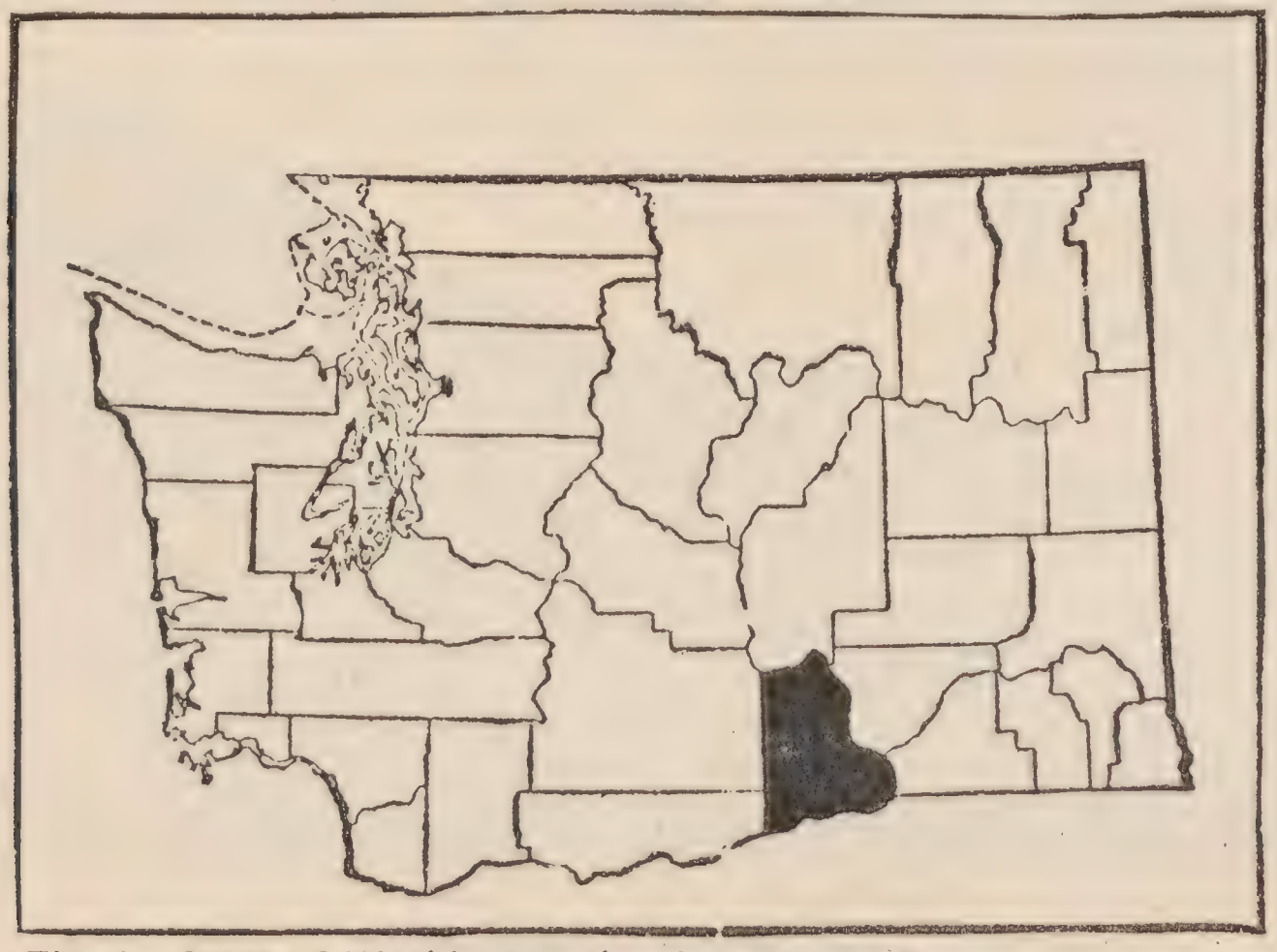

Fig. 1.—State of Washington showing Benton County (in black). Reproduced by permission of the U. S. Bureau of Soils.

Fig. 2.—Sagebrush (*Artemisia tridentata*) on Columbia River Plains, west of Hanford.
Photo by H. St. John

lectors. For this reason a list has been added of the plants that are likely to be found in this county.

In most cases common names have been provided. Although many of these are by no means in general use and might better be called *uncommon names,* it has been thought best to attach a suitable coloquial name whenever one was known with the hope that these names will be of use to those who might want a popular name. Abram's "Flora of the Pacific States", Rydberg's "Flora of the Rocky Mountains and Adjacent Plains", and Frye and Rigg's "Northwest Flora" have been frequently consulted in the quest for suitable "common names."

Description of Area

Benton County, the area under consideration, is a part of the extensive treeless region of eastern Washington, and is situated in the southern portion of the great Columbia Plateau about one hundred miles west of the Idaho boundary in south-central Washington. It has a area of 1,671 square miles. On the north, east, and south it is bounded by the Columbia River and on the west by Yakima and Klickitat counties. The entire region, except the irrigated districts, is devoid of any extensive tree growth and the conspicuous native herbaceous vegetation consists chiefly of sagebrush and bunchgrass.

Topography

For an understanding of the distribution of the plants of this county, a brief account of the topography is essential.

The county is naturally divided into two areas of similar extent by the Yakima River which flows in a easterly direction across the central portion of the county, entering at a point about 5 miles west of Prosser and joining the Columbia River at Richland. Its valley is from two to four miles in width.

North of the Yakima River are the Rattlesnake Hills which extend in a

general south-easterly direction from Yakima County. Their altitude at the highest point is over 3500 feet. The north slope of these hills is steep but on the south side the rise is long and gradual.

South of the Yakima River the Horse Heaven Hills rise abruptly to the height of from 1500-2000 feet to the nearly level region known as the Horse Heaven Plateau. This slopes gently south and east to the Columbia River and covers approximately 500 square miles.

Both the Rattlesnake and the Horse Heaven Hills are cut by numerous draws or ravines from 50 to 500 feet deep through which small streams flow when the snow melts or for a short time after heavy rains. There are also a few small springs on the north side of the Rattlesnake Hills, some of which serve to irrigate about 65 acres of the Benson Ranch.

In several parts of the county there are extensive areas known as the Columbia River Plains. The largest of these plains lies north and east of the Rattlesnake Hills. These plains consist, for the most part, of level or gently rolling desert-like stretches with a sagebrush, *Artemisia tridentata,* as the dominant plant.

Geology and Soil

The greater portion of eastern Washington is underlain by an immense mass of basalt in some places more than 2500 feet in thickness. This dark-colored rock, known as the Columbia River Basalt, is the result of a series of lava flows which occured during the Miocene, and which almost completely cover all of the older rocks. Most of the surface of this region is composed of light-brown, fine-grained river silt, with sands and gravels, which cover the basalt many feet deep. There are, however, frequent rock outcroppings in the rougher parts of the county known as scab-rock areas.

Climate

As this county lies in the arid section of the state it is practically shut off by the Cascade Mountains from the moderating winds from the ocean and is therefore subject to extremes of temperature. At Kennewick the mean annual precipitation is 6.34 inches. It is slightly

Fig.3.—Drifting sand, and hills covered with sagebrush (*Artemisia tridentata*) north of Kiona. Photo by F. L. Pickett

heavier in the Rattlesnake and Horse Heaven Hills where the snowfall is sometimes two feet or more and lies on the ground for several weeks. At Kennewick there is an average growing season of 170 days. The prevailing winds are from the southwest and are strongest during the spring and early summer. They not infrequently attain a velocity of 30 or 40 miles per hour, and last for several days at a time, creating dust-storms and causing extensive sand drifts in the areas of lighter soils. These winds greatly increase the evaporating power of the air.

Vegetation

Ecologically, the region may be divided into four areas:

1. Bunchgrass Area.
2. Sagebrush Area.
3. River-bank Thickets.
4. Irrigated Areas.

1. *Bunchgrass Area*: Arid Transition Zone.—Of the herbaceous vegetation in the bunchgrass areas probably the most important plant is the bunchgrass, *Agropyron spicatum*. Prior to the early nineties, which marked the beginning of irrigation in the valleys, the nutritious bunchgrass with which the hills were luxuriantly covered supplied grazing for large numbers of horses and cattle which were shipped annually from this region. After 1900, settlers began to arrive and large areas of the grazing land were plowed and seeded to wheat. In this region of low rainfall, light soil and high winds, the land produces a small crop only once in two years and, by 1913 the majority of the settlers had abandoned their farms. At the present time, however, there is still a considerable area of wheat land under cultivation although the areas fit for agriculture are rather limited in extent.

In many of the ravines and about springs there are small groves of willows, *Salix* spp., hawthorne, *Crataegus Douglasii*, two species of service-berry, *Amelanchier Cusickii* and *A. utahensis*, the aspen, *Populus tremuloides*, syringa, *Philadelphus Lewisii*, snowberry, *Symphoricarpos albus*, choke-cherry, *Prunus melanocarpa*, wild rose, *Rosa ultramontana*, two species of currants, *Ribes cereum* and *R. aureum*, and also occasionally, the elderberry, *Sambucus caerulea*.

On the bunchgrass prairies, some of the more common plants are: white evening primrose, *Oenothera pallida*, four species and varieties of *Lupinus, four* species and a variety of *Lomatium, Dodecatheon Cusickii, Phacelia heterophylla, Lithospermum ruderale*, two species of *Mertensia, Achillea lanulosa, Gilia humilis, Chaenactis Douglasii, Rumex venosus*, two species of *Delphinium, Erysimum occidentale, Sisymbrium incisum, var. filipes*, and *Erodium cicutarium*.

2. *Sagebrush Area*: Upper Sonoran Zone.—Plants of this region are mostly either shrubs, thick-rooted perennial herbs, or short-lived annuals. Several species of small shrubs occur in this region, the most abundant being, of course, the sagebrush, *Artemisia tridentata*. The rabbit-brushes, *Chrysothamnus nauseosus*. ssp. *speciosus, C. viscidiflorus*, ssp. *lanceolatus, C. viscidiflorus, ssp. pumilus*. the hop sage, *Grayia spinosa*, the black sage, *Purshia tridentata* and, in the deeper soils with a high alkaline content, the greasewood, *Sarcobatus vermiculatus*.

Among the herbaceous vegetation, the cactus or prickly-pear is not uncommon, growing in clumps and often spreading over considerable areas. The balsam-root, *Balsamorhiza Careyana*, is quite common, and in the spring is very attractive with its large yellow flowers contributing color to an otherwise almost colorless landscape. In rocky soil the sagebrush parsley, *Pteryxia terebinthina*. is fairly abundant and most conspicuous in the spring. Later in the season, the white evening-primrose, *Oenothera pallida*, with its delicate white or pinkish

flowers, ballsage, *Ramona incana,* and two Pentstemons, *P. glaber* and *P. acuminatus,* are some of the characteristic plants of the Upper Sonoran Zone.

3. *River-Bank Thickets.*—Along the banks of the Yakima and Columbia rivers there is commonly a narrow strip, which, owing to the relatively larger amount of available moisture and the greater protection from winds, supports a flora consisting of trees, shrubs, lianas and herbs. In fact, with the exception of some of the ravines in the hills, the only tree growth of any size in the area occurs here.

There are occasional groves of larger trees such as cottonwood, *Populus hastata,* and tree willows, *Salix amygdaloides* and *S. caudata.* In many places there are thickets of hawthorn, *Crataegus Douglasii,* bush willows, *Salix Scouleriana, S. exigua, S. lutea* and *S. Bebbiana,* golden currant, *Ribes aureum,* and syringa, *Philadelphus Lewisii. Clematis ligusticifolia* occurs quite commonly climbing among these thickets. Along the Yakima River, the smooth sumach, *Rhus glabra,* occurs in patches.

Characteristic herbs of these river bank thickets are: Rye-grass, *Elymus condensatus, Coreopsis Atkinsoniana,* milkweed, *Asclepias speciosa,* wild licorice, *Glycyrrhiza lepidota,* bittersweet, *Solanum Dulcamara,* bur-marigold, *Bidens cernua,* cocklebur, *Xanthium italicum,* and at the river's-edge occur *Eleocharis palustris* and *E. monticola,* var. *pallida* and several species of *Carex* and *Cyperus.*

4. *Irrigated Areas.*—The irrigated areas are confined to the valleys. At the present time there are about 35,000 acres under irrigation in Benton County. The area is divided into four districts: Richland-Kennewick District, Prosser District, Benton City District, and the Hanford-White Bluffs District.

Around the edges of swamps, *Typha latifolia* and *Phalaris arundinacea* are fairly common, and in the low meadows about Prosser in late April and May, *Iris missouriensis* is conspicuous.

Along the irrigation ditches quite a distinct association appears. *Echinochloa crusgalli* and the variety *mitis* and *Panicum capillare* are abundant. *Melilotus alba* grows 2-3 meters high and is a good bee plant. Another species, *M. officinalis,* has been recently introduced and may be seen occasionally along the roadsides. Two Willow-herbs, *Epilobium angustifolium* and *E. glandulosum,* var. *adenocaulon,* thrive in the moist ground along the ditches, the latter species being the most abundant. *Cicuta occidentalis, Lycopus lucidus, Mentha arvensis,* var. *lanata, Bidens cernua, Gnaphalium chilense* and two species of Golden-rod, *Solidago elongata* and *S. occidentalis,* are also quite common in the late summer and autumn. In moist ground along the roadsides and irrigation ditches, *Verbena hastata* may be seen occasionally.

In the ditches themselves, a species of *Nitella, Potamogeton Richardsonii* and *Lemna minor* are not uncommon.

There are several native weeds. *Cleome lutea* is rather abundant in the eastern part of the county, sometimes occuring in fields although it is more commonly seen along the roadsides. *Amsinckia tessellata* is a troublesome weed in the wheat fields at harvest time. *Aster canescens,* var. *viscosus* is a native that has become common in waste places and cultivated ground. Two species of Atriplex, *A. patula, subsp. hastata,* and *A. truncata* are very abundant in alkaline soils. *Verbena bracteosa,* a prostrate plant, is common along roadsides and in cultivated ground. In dry sandy soil, the Bur-grass, *Cenchrus pauciflorus,* is becoming a troublesome weed in some places, and in alkaline soil, especially about Kennewick, the heliotrope, *Heliotropium curassavicum,* is quite abundant.

The introduced species of weeds are by far the most numerous. Following is a list of the more common ones:

Bromus hordaceus, B. tectorum, Phleum pratense, Poa annua, Setaria viridis, Polygonum aviculare, Rumex Acetosella, Chenopodium album, C. Botrys, Kochia californica, Salsola Kali, var. tenuifolia, Mollugo verticillata, Portulaca oleracea, Stellaria media, Capsella Bursa-pastoris, Hymenophysa pubescens, Lepidium Draba, L. perfoliatum, Sisymbrium altissimum, Erodium cicutarium, Malva rotundifolia, Convolvulus arvensis, Cuscuta epithymum, Marrubium vulgare Verbascum Thaspus, Solanum luteum, Plantago lanceolata, P. major, Cichorium Intybus, Cirsium lanceolatum, Erigeron canadense, Lactuca scariola, var. integrata.

Within the last thirty years several plants not considered weeds have become established in the county. In places where there is sufficient moisture, the locust tree, *Robinia Pseudo-Acacia,* box-elder, *Acer Negundo,* and white poplar, *Populus alba* often appear spontaneously. In orchards and along irrigation ditches *Asparagus officinalis* is a common plant. *Humulus Lupulus* may be seen twining along the fences and the box-thorn or matrimony-vine, *Lycium chinense,* has made itself at home in many places in old fence-corners and about old dwellings.

Plants Which Will Probably Be Found To Occur In Benton County

The following list contains a number of species that are known to occur near the boundaries of Benton Co. and which will probably be found within the County upon further exploration.

Argropyron caninum (L.) Beauv.
A. repens L.
Alisma Plantago-aquatica L.
Astragalus sclerocarpus Gray.
Artemisia Lindleyana Besser.
Balsamorhiza sagittata (Pursh) Nutt.
Betula microphylla Bunge.
Capnorea lasiantha Greene.
Castilleja exilis A. Nels.
Carex hystricina Willd.
Cerastium arvense L.
C. viscosum L.
Clarkia pulchella Pursh.
Cyptantha pterocarya (Torr.) Greene.
Eriophorum gracile Roth., var. caurianum Fern.
Gilia filifolia Nutt.
G. gracilis (Dougl.) Hook.
G. leptomeria Gray.
Helianthella Douglasii T. and G.
Hordeum murinum L.
Hutchinsia procumbens (L.) DC.
Hypochaeris radicata L.
Leptotaenia multifida Nutt.
Lobelia Kalmii L.
Lomatium brevifolium C. and R.
Lupinus aridus Dougl., var. intermontanus (Heller) C. P. S.
L. sericeus Pursh.
L. Wyethii Wats.
Mentzelia integrifolia (Wats.) Rydb.
Oxytheca dendroides Nutt.
Phacelia glandulifera Piper.
Polygonum majus (Meisn.) Piper.
Rhus Toxicodendron L.
Ribes inerme Rydb.
R. iriguum Dougl.
Salix Piperi Bebb.
Senecio Balsamitae Muhl.
S. vulgaris L.
Sitanion Hystrix (Nutt.) J. G. Smith.
Sphaerostigma andinum (Nutt.) Walp.
S. Boothii (Dougl.) Walp.
S. contortum (Dougl.) Walp.
Streptanthus longirostris Wats.
Taraxacum laevigatum DC.

ANNOTATED CATALOGUE

POLYPODIACEÆ. Fern Family

[**Adiantum pedatum** L. Maiden-hair Fern. A doubtful record of this fern from Benton County is based on one specimen which was reported to have been found by **Miss Ruth L. Bennett** in April 1926, growing near a spring in a moist shaded place among rocks in Black Canyon, Rattlesnake Hills.]

Woodsia oregana D. C. Eaton. Oregon Woodsia. Rattlesnake Hills, Cotton 422, **St. John** 8101.

MARSILEACEÆ

Marsilea vestita Hook. and Grev. Gravelly beach of the Columbia River at Paterson, **St. John** 8060.

EQUISETACEÆ. Horsetail Family

Equisetum arvense L. Common Horsetail. Growing in moist ground at Prosser, G. N. **Jones** 315.

E laevigatum A. Br. Braun's Scouring-rush. Kiona, **Cotton** 735.

E. hyemale L. Western Scouring-rush. Along Columbia River at Kennewick, **St. John** 8079.

PINACEÆ. Pine Family

[**Pinus ponderosa** Dougl. Yellow Pine Included on the basis of two small trees growing on the gravelly beach of the Columbia River doubtfully native at Paterson, **St. John** 8073.]

Juniperus occidentalis Hook. Western Juniper. "Sandy bank of the Yakima River, 3 miles west of Richland."—**Harold E. Willmsen,** October 23, 1926.

J. scopulorum Sarg. Rocky Mountain Juniper. Three trees, 3-4 meters in height, growing in the gravelly bed of the Columbia River, 6 miles northwest of White Bluffs, **G. N. Jones** 421.

TYPHACEÆ. Cat-tail Family

Typha latifolia L. Cat-tail. Abundant along irrigation ditches and in swampy places.

NAJADACEÆ. Pondweed Family

Potamogeton Richardsonii (Benn.) Rydb. Richardson's Pondweed. Prosser, in irrigation ditch, **Cotton** 809.

Zanichellia palustris L. Horned Pondweed. Along Columbia River, in shallow water, **G. N. Jones** 368.

JUNCAGINACEÆ. Arrow-grass Family

Triglochin maritima L. Seaside Arrow-grass. Growing in marshy places along Columbia River at Kennewick, **G. N. Jones** 374. Under certain conditions this plant is poisonous to sheep and cattle.

ALISMACEÆ. Water-plantain Family

Sagittaria cuneata Sheldon. Wappatoo. Along Yakima River at Prosser, **Cotton** 806; Kennewick, along Columbia River, **G. N. Jones** 375. Wappatoo is the Indian name for this plant. In the Fall the root-stocks develop white, starchy tubers which were formerly widely used for food by the Indians.

GRAMINEÆ. Grass Family

Alopecurus aequalis Sobol. Meadow Foxtail. Richland, **Beattie** 3939; gravelly beach of Columbia River, Hanford, **St. John** 8122.

Agropyron occidentale Scribn. Western Wheat-grass. Reported from Benton City.

A. spicatum (Pursh.) Scribn. and Smith. Bunchgrass. The most abundant grass of the "bunchgrass prairies" of eastern Washington. In Benton Co. these prairies are confined to the high plateaus of the Rattlesnake Hills and the Horse Heaven Hills This is the most valuable grass of the dry regions.

A. spicatum (Pursh) Scribn. and Smith., var. **inerme** (Scribn. and Smith) Heller. Prosser, **G. N. Jones** 351, **Cotton** 1081.

A. dasystachyum (Hook) Scribn. Downy Wheat-grass. In dry, sandy soil. Prosser, **Cotton** 634; Kiona, **Cotton** 719.

A. tenerum Vasey. Slender Wheat-grass. Along irrigation ditch at Prosser, **Cotton** 744; Rattlesnake Hills, **Cotton** 667.

Agrotis alba L. Redtop. Prosser, **G. N. Jones** 316, 412, 407, 310.

Bromus carinatus H. & A. California Brome-grass. Hanford, **Beattie** 3950.

B. hordeaceus L. Soft Cheat. A weed in waste places and cultivated ground. **Griffiths and Cotton** 9.

B. hordeaceus L., forma **leptostachys** (Pers.) Wiegand. Smooth-flowered Soft Cheat, Cold Creek **Cotton** 495; Prosser, **Cotton** 1110, 1111.

B. marginatus Nees. Rattlesnake Hills, **Griffiths and Cotton** 6; **Cotton** 688, 680; Cold Creek, **Cotton** 401.

B. tectorum L. Downy Brome-grass. Roadsides and waste places. Has been collected at Paterson and reported from Kennewick.

B. tectorum L., var. **nudus** Klett. and Richter. Smooth-flowered Brome-grass. Prosser, **G. N. Jones** 382.

Cenchrus pauciflorus Benth. Bur-grass. Becoming frequent as a weed in sandy soil in the irrigated areas. Prosser, **G. N. Jones** 420. Also reported from Benton City and Kennewick.

Dactylis glomerata L. Orchard-grass. Reported from Benton City and Prosser.

Digitaria sanguinalis (L.) Scop. Crab-grass. A weed in cultivated ground. Reported from Kennewick and Hover.

Distichlis spicata (L.) Greene. Salt Grass. Kiona, **Cotton** 717.

Echinochloa crusgalli (L.) Beauv. Barnyard Grass; Jungle Rice. Kennewick, **G. N. Jones** 365. This and the following are very abundant in the irrigated areas. They prefer nitrogenous soil and have a high forage value.

E. crusgalli (L.) Beauv., var. **mitis** (Pursh) Peterm. Prosser, **G. N. Jones** 336, **Cotton** 892.

Elymus canadensis L. Canada Rye-grass. Rocky banks of the Yakima River at Kiona, **Cotton** 728

E. condensatus Presl. Giant Rye-grass Reported from Prosser and Benton City. A tall grass 1-2 meters high growing in bunches along river-banks and canyons.

E. flavescens Scribn. & Smith. Yellow Rye-grass. Sandy soil, Plymouth, **St. John** 8850.

E. triticoides Buckl. Alkali Rye-grass. Prosser, **H. P. Singleton.**

Eragrostis lutescens Scribn. Viscid Eragrostis. Collected near Kennewick by Elmer in 1897.

Festuca elatior L. Meadow Fescue. A-

long irrigation ditches, July 2, 1925, Hanford, **Wm. S. Webber.**

F. idahoensis Elmer. Blue Bunchgrass. Rattlesnake Hills, **Griffiths and Cotton** 21.

F. octoflora Walt. Slender Fescue. Prosser, **Leckenby** 2817; Rattlesnake Hills, **Griffiths and Cotton** 15; **Cotton** 410.

F. pacifica Piper. Pacific Fescue. Rattlesnake Hills, **Cotton** 472; Prosser, **Griffiths and Cotton** 16.

Hierochloa odorata (L.) Wahl. Vanilla Grass. Along Columbia River at Kennewick, **St. John** 8078.

Holcus halepensis (L.) Pers. Johnson Grass. Reported common along irrigation ditches at Kennewick.

Hordeum caespitosum Scribn. Tufted Barley. Prosser, **G. N. Jones** 390; Kiona, **Cotton** 718.

H. jubatum L. Squirrel Tail. A bad weed in meadows. Reported from Kennewick. The sharply-jointed and awned seeds of this grass sometimes causes inflamation and ulcerating sores in the mouths of horses and cattle.

Koeleria cristata (L.) Pers. Koeler's Grass. White Bluffs, **R. Kent Beatie** 3957.

Lolium multiflorum L. Italian Ryegrass. Prosser, **G. N. Jones** 309.

Muhlenbergia squarrosa (Trin.) Rydb. Prosser, **Cotton** 636.

Oryzopsis membranacea (Pursh) Vasey. Indian Mountain Rice. Rattlesnake Hills. **Cotton** 421; Prosser, **Griffiths and Cotton** 11; Plymouth, **St. John** 8077.

Panicum capillare L. Old Witch Grass. In cultivated ground and along irrigation ditches, Prosser, **Cotton** 891. Also reported from Kennewick.

Phalaris arundinacea L. Reed Canarygrass. A native grass, making good forage, growing in swamps and wet ground. Reported from Richland.

Phleum pratense L. Timothy. Roadsides, waste places and along irrigation ditches. Reported from Benton City.

Poa annua L. Annual Bluegrass. Roadsides and waste places. Paterson, **St. John** 8058. Reported from Prosser.

P. brachyglossa Piper. Alkali Bluegrass. Usually growing in alkaline soils. Cold Creek, **Cotton** 402; Rattlesnake Hills, **Cotton** 664; Prosser, sandy banks of the Yakima River, **Cotton** 627.

P. Cusickii Vasey. (P. Cottoni Piper.) Rattlesnake Hills, **Cotton** 557, **Griffiths and Cotton** 4, 20.

P. pratensis L. Kentucky Bluegrass. Established in irrigated lands. Prosser, **Griffiths & Cotton** 12; Prosser, **G. N. Jones** 310.

Puccinellia Suksdorfii St. John, sp. nov. A caespitose annual, 1-5 dm. high; basal leaves numerous, glaucous green, their sheaths 1-2 cm. long smooth, the ligule membranous hyaline rounded 1 mm. long, the blades narrowly linear, smooth acute, strongly involute, 2-5 cm. long, 0.5-1.5 mm. wide; cauline leaves 2-3, those of autumnal stems similar to the basal leaves, those of the few aestival stems coarser with sheaths 4-7 cm. long, and blades flat 4-10 cm. long, 3-4 mm. wide; vigorous plants producing one to several aestival culms 4-5 dm. high with a panicle 12-20 cm. long; these larger plants producing autumnal stems and the smaller plants producing only these smaller culms which are numerous and equal 5-20 cm. high, smooth and slender, the uppermost internode exceeding the blade; panicle ovoid loose, its branches at anthesis divergent or some of them reflexed, spikelet-bearing on the outer half, scabrous; spikelets 3-8 flowered, 3-6 mm. long; first glume ovate ciliolate or erose towards the tip, 1-nerved 0.5-1 mm. long; second glume ovate and similar, but 3-nerved and 1-1.3 mm. long; lemmas broadly elliptic obtuse, 1.6-2.1 mm. long, green below, but suffused on the back with purplish or brown, hyaline on the margins and tip, sparsely pilose at base, ciliolate towards the apex, 5-nerved; palea boat-shaped, with two strong dark ciliate nerves,, 2 mm. long; anthers 0.5-0.7 mm. long; grain 1-1.5 mm. long.

Annua cespitosa, foliis involutis, panicula diffusa ramis divergentibus deinde deflexis, spiculis 3-6 mm. longis, lemmatibus 5-nervatis 1.6-2.1 mm. longis ciliolatis, antheris 0.5 mm. longis, caryopsibus 1-1.2 mm. longis.

Washington: Sandy ground, border of a pond near Rockland, Klickitat Co., June 2, 1905, *W. N. Suksdorf* 5089 (type in Herb. State College of Washington); in alkali soil, Yakima City, July 10, 1897, *C. V. Piper* 2590; alkaline

meadow, Yakima, July 6, 1927, *G. N. Jones* 640; baked clay flat, Prosser, Aug. 1926, *G. N. Jones* 317; mud flats, Alkali Lake, Amber, Spokane Co., Sept. 26, 1926, *H. St. John, L. Mullen & F. Warren* 4879; sandy shore of Medical Lake, Spokane Co., Sept. 28, 1924, *H. St. John, T. A. Bonser & F. Warren* 6755.

This new species is most closely related to the Eurasian *P. distans* (L.) Parl., and its var. *tenuis* (Uechtritz) Fern. & Weath. These have been introduced into eastern North America and have become established particularly near the seaport towns. One of the specimens cited above, *Piper* 2590, was listed by Fernald and Weatherby in their monograph as the var. *tenuis*. However, it and the other Washington specimens cited above are certainly native plants of the alkaline flats and pond shores in the interior dry belt. Besides other characters they differ from the European plants in having the second glume 1-1.3 mm. long, the lemmas 1.6-2.1 mm. long, and the anther 0.5-0.7 mm. long. *P. distans* and its var. *tenuis* are distinguished by having the second glume 2 mm. long, the lemmas 2-2.5 mm. long (1.5-2 in var. tenuis), and the anther 0.7-0.9 mm. long.

Setaria lutescens (Weigel) Hubb. Pigeon Grass. Introduced at Prosser, **G. N. Jones** 391.

S. viridis L. Green Foxtail. A common weed in waste places and cultivated ground. Prosser, **G. N. Jones** 391. Also reported from Kennewick.

Spenopholis obtusata (Michx.) Scribn. Banks of the Yakima River at Kiona. **Cotton** 733.

Sporobolus cryptandrus (Torr.) Gray. Sand Dropseed. Kiona, **Cotton** 726; Prosser, gravelly places along the Yakima River, Cotton 914.

Stipa comata Trin. & Rupr. Needle and Thread Grass. Dry sage lands, Horse Heaven, **St. John** 8640.

CYPERACEÆ. Sedge Family

Carex aperta Boott. Columbia Sedge. Richland, **Beattie** 3936.

C. athrostachya Olney. Slender-beaked Sedge. Moist ground along the Columbia River at Kennewick, **G. N. Jones** 355.

C. aurea. Nutt. Golden-fruited Sedge. Rattlesnake Hills, in wet ground, elev. 3400 ft., **Cotton** 709.

C. Douglasii Boott. Douglas's Sedge. Rattlesnake Hills, **Cotton** 572; Prosser, sandy soil along Yakima River, **Cotton** 1079; Paterson, gravelly beach of the Columbia River, **St. John** 8057; the Columbia River at Coolidge.

C. filifolia Nutt. Thread-leaved Sedge. Moist places in the Rattlesnake Hills, appearing in early spring, **Cotton** 329.

C. Kelloggii W. Boott. Kellogg's Sedge. Richland, **Beattie** 3938.

C. lanuginosa Michx. Prosser, **G. N. Jones** 313.

C. microptera Mack. Small-winged Sedge. Rattlesnake Hills, **Cotton** 700.

C. vulpinoidea Michx. Fox Sedge. Gravelly river banks, Kiona, **Cotton** 732.

Cyperus aristatus Rottb. Awned Cyperus. Prosser, in moist gravelly soil, **Cotton** 644. The dry plant has the odor of Slippery Elm.

C. erythrorhizos Muhl. Red-rooted Cyperus. Kennewick, **G. N. Jones** 357.

Eleocharis palustris (L.) Roem. and Schult. Creeping Spike-rush; Wire-grass. Prosser, **Cotton** 660, **G. N. Jones** 383; Kennewick, **G. N. Jones** 372; Richland, **Beattie** 3940.

Eleocharis monticola Fernald, var. *pallida* St. John, n. var. This variation differs from the species in having the scales of the spikelet pale and with broad white scarious margins. Brown coloring, when present, is restricted to a very narrow strip near the narrow midrib. The scales are very obtuse. The species, on the other hand, has the scales a chestnut brown to purplish and acute or merely bluntish.

Ab specie differt in squamis pallidis obtusis. Washington: Parker, Aug. 8, 1901, *A. D. Dunn* (type in Herb. State College of Washington); along Yakima River, Prosser, Aug. 1926, *G. N. Jones* 402.

LEMNACEÆ. Duckweed Family

Lemna minor L. Lesser Duckweed. Floating on stagnant water, Richland, **H. E. Willmsen**, October 23, 1926.

JUNCACEÆ. Rush Family

Juncus balticus Willd. Baltic Rush Richland, **Beattie** 3941.

J. columbianus Cov. Columbia Rush. Snipes Creek, **Cotton** 668; Rattlesnake Hills, **Cotton** 669½ in part.

J. Dudleyi Weig. Dudley's Rush. Prosser, **G. N. Jones** 318.

J. Regelii Buch. Regel's Rush. Snipes Creek, **Cotton** 669½ in part.

J. Torreyi Cov. Torrey's Rush. Prosser, **Cotton** 648, **G. N. Jones** 340.

LILIACEÆ. Lily Family

Allium macrum Wats. Rattlesnake Hills, **Miss Ruth L. Bennett,** April 13, 1926.

A. acuminatum Hook. Hooker's Onion. Rattlesnake Hills, **Miss Ruth L. Bennett,** April, 1926.

A. cernuum Roth. Nodding Onion. White Bluff Ferry, **Lake and Hull,** August 11, 1892.

A. Geyeri S. Wats. Geyer's Onion. Prosser, **Cotton** 1087, **L. F. Henderson,** May 26, 1892.

A. pleianthum S. Wats. Many-flowered Onion. Has been collected at Coolidge, along the beach of the Columbia River.

A. Schoenoprasum L. var. **laurentianum** Fern. Wild Chives. White Bluff Ferry, **Lake and Hull,** August 9, 1892; White Bluffs, **Beattie** 3964; five miles southeast of Priest Rapids, on gravelly shore of Columbia River, **St. John** 3319.

Asparagus officinalis L. Asparagus. Escaped from cultivation and becoming a common weed in cultivated ground throughout the irrigated districts.

Brodiaea grandiflora (Lindl.) Macbride Wild Hyacinth. Rattlesnake Hills, **Miss Ruth L. Bennett,** April 19, 1926; Wautoma, **St. John** 8108. It has also been collected at Paterson.

Calochortus macrocarpus Dougl. Sego Lily. Dry sage lands, Horse Heaven, **St. John** 8638.

Fritillaria pudica (Pursh) Spreng. Yellow-bell. Rattlesnake Hills, **Miss Ruth L. Bennett** 21; Hanford, **St. John** 8113.

Smilacina stellata (L.) Desf. Solomon's Seal. Prosser, **Miss Hazel Evans** 27; Rattlesnake Hills, **Cotton** 578.

Zigadenus paniculatus Wats. Death Camas. Rattlesnake Hills, **Miss Ruth L. Bennett; Cotton** 336.

IRIDACEÆ. Iris Family

Iris missouriensis Nutt. Western Blueflag or Iris. Prosser, in low moist meadows, **Cotton** 1085, **Henderson,** May 26, 1892. **Miss Ruth L. Bennett** 47.

Sisyrinchium idahoense Bickn. Idaho Blue-eyed Grass. Wet meadows, near Prosser, **Henderson** 2543.

SALICACEÆ. Willow Family

Populus alba L. White Poplar. Spontaneous in many places in the irrigated districts; frequently planted as a shade tree.

P. hastata Dode. Cottonwood. Rattlesnake Hills, **St. John** 8096; also occurs along the Yakima and Columbia Rivers at various places.

P. nigra L., var. **italica** Du Roi. Lombardy Poplar. Very commonly planted and apparently spontaneous in many places.

P. tremuloides Michx. Aspen. Along creeks and river banks. Prosser, **G. N. Jones** 314.

Salix amygdaloides Anderss. Peach-leaved Willow. Prosser, along Yakima River. **G. N. Jones** 396, **Cotton** 1078a.

S. Bebbiana Sarg. Bebb Willow. Rattlesnake Hills, **Cotton** 325; Prosser, along the Yakima River, **G. N. Jones** 394.

S. caudata (Nutt.) Heller. Caudate Willow. Prosser, along the Yakima River, **Cotton** 1078.

S. exigua Nutt. Slender Willow. Along the Yakima River at Prosser, **G. N. Jones** 395; Kiona, **Cotton** 720.

S. lasiolepis Benth. Arroyo Willow. Rattlesnake Hills, **Cotton** 326.

S. monochroma Ball. One-colored Willow. Hover, **C. S. Parker** 316.

S. lutea Nutt. Yellow Willow. Prosser, **Griffiths and Cotton** 14.

S. Scouleriana Barratt. Scouler Willow. This is very variable as to foliage and habit. Rattlesnake Hills, **St. John** 8086. 8087; Prosser, **St. John** 8054.

URTICACEÆ. Nettle Family

Humulus Lupulus L. Common Hop. A frequent escape from cultivation. Reported from Benton City.

Urtica Lyallii Wats. Common Nettle. Rattlesnake Hills, **St. John** 8081.

U. serra Blume. Toothed Nettle. Prosser, **G. N. Jones** 400.

SANTALACEÆ. Sandalwood Family

Commandra pallida A. DC. Hanford, **St. John** 8114. Fruits edible; plant parasitic, growing in dry gravelly soil.

POLYGONACEÆ. Buckwheat Family

Eriogonum compositum Dougl. River shores, White Bluffs, **Beattie** 3958, 3968.

E. elatum Dougl. Tall Eriogonum. White Bluff Ferry, **Lake and Hull,** August 11, 1892.

E. heracleoides Nutt. Parsnip-flowered Eriogonum. Rattlesnake Hills, **Cotton** 404.

E. niveum Dougl. Prosser, **Cotton** 899. Also reported from Benton City.

E. proliferum T. and G. White Bluffs, **R. Kent Beattie** 3969; Horse Heaven Hills, **H. R. Mewhinney**, May 3, 1922; Rattlesnake Hills, **Cotton** 711. Has also been collected at Coolidge.

E. sphaerocephalum Dougl. Rattlesnake Hills, **Cotton** 714; Cold Creek, **Cotton** 1407; Kiona, **Cotton** 725.

E. thymoides Benth. Rattlesnake Hills, **Cotton** 361, 362; Prosser, **Cotton** 590. Also reported from Hover.

E. vimineum Dougl. Prosser, **Cotton** 807.

Polygonum aviculare L. Knot-grass. A common weed everywhere. Prosser, **G. N. Jones** 333.

P. Convolvulus L. Black Bindweed. Waste ground, introduced; reported from Benton City.

P. Douglasii Greene. Douglas' Knotweed. Has been collected at Coolidge.

P. Muhlenbergii (Meisn.) Wats. Swamp Persicary. River banks and edges of ponds, Prosser, **Cotton** 812. Also reported from Benton City.

P. Hydropiper L. Smart-weed; Water Pepper. Along the Columbia River at Kennewick, **G. N. Jones** 370.

P. Persicaria L. Lady's Thumb; Heartweed. Reported from Kennewick and Benton City.

Rumex Acetosella L. Sheep Sorrel or Sour-grass. A common introduced weed in waste places and cultivated ground. Its presence usually indicates a lack of calcium carbonate in the soil.

R. crispus L. Yellow Dock. Waste places and along roadsides.

R. mexicanus Meisn. Willow-leaved Dock. Gravelly beach of the Columbia River at Hanford, **St. John** 8126. Also reported from Kennewick and Benton City.

R. venosus Pursh. Veined Dock. Native in sandy soil, locally abundant throughout the county. Rattlesnake Hills, **Miss Ruth L. Bennett** 53.

CHENOPODIACEÆ. Goosefoot Family

Atriplex patula L., ssp. **hastata** Hall and Clements. Spear-leaved Saltbush; Spearscale. Prosser, **G. N. Jones** 384. A halophytic annual occuring in alkaline soil; reported also from Kennewick.

A. rosea L. Red Saltbush; Redscale. Richland, **H. E. Willmsen**, October 23, 1926. Often very abundant in alkaline soil, flowering from July to September.

A. truncata (Torr.) Gray. Wedge-leaved Saltbush; Wedgescale. Prosser, **G. N. Jones** 335. Common in alkaline soil, flowering somewhat earlier than the preceeding.

Chenopodium album L. Lamb's Quarters; Pigweed. A common weed in waste places and cultivated ground.

C. Botrys L. Jerusalem Oak. An European weed that is becoming common in many places. Plant with a strong odor.

C. leptophyllum (Moq.) Nutt. Slender-leaved Goosefoot. A native weed in dry ground. Prosser, **G. N. Jones** 322, 385.

Corispermum hyssopifolium L. Bug-seed. Reported from Kennewick.

C. villosum Rydb. Hairy Western Bug-seed. Rattlesnake Hills, **Cotton** 885; Patterson, **E. A. Dutton**, September 15, 1924.

Eurotia lanata (Pursh) Moq. White Sage. Rattlesnake Hills, **A. D. Dunn** 184.

Grayia spinosa (Hook.) Moq. Hop Sage. Alkaline soil, locally abundant. White Bluffs, **J. C. Scott**, May 31, 1922; Prosser, **Griffiths and Cotton** 16; Hanford, **St. John** 8109.

Kochia californica Wats. Becoming very abundant in waste ground and along roadsides. Prosser, **G. N. Jones** 386, **C. C. Wright**, August 8, 1924.

Salsola Kali L., var. **tenuifolia** G. W. F. Mey. Russian Thistle. A very abundant and troublesome weed, growing everywhere. When young, relished by stock.

Sarcobatus vermiculatus (Hook.) Torr. Greasewood. Prosser, **G. N. Jones** 343; Hover, **C. S. Parker** 655. This is the true greasewood although some other plants are known locally by this name. Greasewood grows in alkaline soils. It has smooth light-colored, spiny branches and fleshy linear leaves. Under most conditions this plant makes good forage, but when hungry animals are grazed where there is little except greasewood, there is danger that poisoning may result due to the presence of sodium and potassium oxalates in the plant.

Suaeda occidentalis Wats. Western Sea Blite. White Bluff Ferry, **Lake and Hull** 678.

AMARANTHACEÆ. Amaranth Family

Amaranthus graecizans L. Tumble Weed. Reported from Kennewick. A common weed in cultivated ground and waste places.

A. paniculatus L. Purple Amaranth. A common weed in cultivated ground. Used as a grain in tropical Asia.

A. retroflexus L. Green Amaranth; Pigweed. Very common in cultivated ground and waste places.

NYCTAGINACEÆ. Four-o'clock Family

Abronia mellifera Dougl. Sand Verbena. Kiona, **Piper** 1807, **Cotton** 724; Prosser, **Henderson** 2439; Paterson, **Miss Lois E. Mathews**, May 14, 1923.

AIZOACEÆ. Carpet-weed Family

Mollugo verticillata L. Carpet-weed. Prosser, **Cotton** 632, **G. N. Jones** 403; also common at Richland.

PORTULACACEÆ. Purslane Family

Lewisia rediviva Pursh. Rock Rose or Bitter Root. Rocky slopes, Rattlesnake Hills, **St. John** 8103.

Portulaca oleracea L. Purslane. Abundant in cultivated ground at Kennewick and Richland.

CARYOPHYLLACEÆ. Pink Family

Cerastium nutans Raf. Powderhorn. Gravelly beaches of Columbia River. Hanford, **St. John** 8124; Paterson, **St. John** 8059.

Silene Douglasii Hook., var. **multicaulis** (Nutt.) Robinson. Rattlesnake Hills, **Cotton** 676.

S. Menziesii Hook. Menzies' Pink. Prosser, **Cotton** 1086; Cold Creek, **Cotton** 398.

Stellaria longipes Goldie. Long-stalked Stitchwort. Cold Creek, **Cotton** 397.

S. media L. Common Chickweed. A very hardy annual weed, growing in waste places and cultivated ground, in lawns and along creeks and river-banks. Plymouth, **St. John** 8045.

RANUNCULACEÆ. Crowfoot Family

Aquilegia formosa Fisch. Western Columbine. Cold Creek, **Cotton** 395.

Clematis ligusticifolia Nutt. Western Clematis. Prosser, **Cotton** 623, **G. N. Jones** 389; Cold Creek, **St. John** 8131.

Delphinium columbianum Greene. Columbia Larkspur. Rattlesnake Hills, **Miss Ruth L. Bennett** 46; Prosser, **Cotton** 583. Has also been collected at Coolidge.

D. depauperatum Nutt. Coolidge, abundant on the sandy cactus flats, **St. John** 8076.

Myosurus apetalus Gray. Mouse-tail. Dry ground among the sagebrush, 15 miles west of Hanford, **St. John** 8129. A common but inconspicuous early spring plant.

Ranunculus aquatilis L., var. **capillaceus** DC. Water Crowfoot. Prosser, **Cotton** 652.

R. Cymbalaria Pursh, var. **saximontanus** Fern. Rocky Mountain Crowfoot. Prosser, **Cotton** 653, **G. N. Jones** 319; Snipes Creek, **Cotton** 414.

R. glaberrimus Hook. Smooth Western Buttercup. Rattlesnake Hills, **Cotton** 307.

R. reptans L., var. **ovalis** (Bigel.) T. and G. Creeping Spearwort. Kennewick, **G. N. Jones** 361.

R. sceleratus L. Celery-leaved Crowfoot. Kennewick, **G. N. Jones** 363; Richland, **R. Kent Beattie** 3935.

CRUCIFERÆ. Mustard Family

Arabis sparsiflora Nutt. Rattlesnake Hills, **St. John** 8095.

Capsella Bursa-pastoris (L.) Medic. Shepherd's Purse. Prosser, **Miss Ruth L. Bennett** 31. A common weed in waste places everywhere.

Cardamine pennsylvanica Muhl. Pennsylvania Bitter-cress. Kennewick, along the Columbia River, **G. N. Jones** 362; Plymouth, **St. John** 8047.

Erysimum occidentale (Wats.) Robinson. Western Wallflower. Prosser, **Cotton** 1103; Rattlesnake Hills, **Miss Ruth L. Bennett** 26; Hanford, **St. John** 8112; Horse Heaven Hills, **Cotton** 584; Paterson, gravelly beach of Columbia River, **St. John** 8061.

Hymenophysa pubescens C. A. Mey. Prosser, **G. N. Jones** 417. Native of the arid regions of southern Siberia. Found for the first time in the United States at Ypsilanti, Mich., in 1916 by B. A. Walpole. First noticed in this state in the Yakima Valley in 1924, and since then it has been reported from various parts of eastern Washington. This plant spreads rapidly by means of underground, perennial root-stocks and promises to become a very serious weed.

Lepidium apetalum Willd. Peppergrass. Prosser, **G. N. Jones** 338. Also reported from Hover.

L. perfoliatum L. Ring-leaved Peppergrass. An European weed first noticed in 1915 in the eastern part and by 1922 it had spread westward into western Washington. At present quite common throughout the state and a troublesome weed in some sections. Plymouth, **St. John** 8050.

Lesquerella Douglasii Wats. Bladderpod. Paterson, gravelly bank of the Columbia River, **St. John** 8072.

Nasturtium officinale R. Br. Water Cress. Banks of the Columbia River at Richland. **Beattie** 3937.

Phoenicaulis Menziesii (Hook.) Greene. Rattlesnake Hills, **Miss Ruth L. Bennett** 27; **Cotton** 551.

Roripa curvisiliqua (Hook.) Bessey. Curved-podded Yellow-cress. Along the Columbia River at Hanford, **St. John** 8121.

R. palustris Bess. Marsh Cress. Kennewick, **G. N. Jones** 358; Prosser, **G. N. Jones** 406.

Sisymbrium altissimum L. Jim Hill Mustard; Tumble Mustard. Very common in the cultivated areas throughout the county The local name of Jim Hill Mustard was given to this plant because it was said to have arrived from the eastern states along the right-of-way of the G. N. R. R.

S. Hartwegianum Fourn. Hartweg's Tansy Mustard. White Bluffs, **R. Kent Beattie** 3967.

S. incisum Engelm., var. **filipes** A. Gray. Western Tansy Mustard. Rattlesnake Hills, **Cotton** 364; Paterson, **St. John** 8056. Common in fields and on hillsides.

S. officinale (L.) Scop. Hedge Mustard. A common weed in waste places.

S. Irio L. Roadside, Prosser, **G. N. Jones** 344. This records the first appearance in this state of this European weed.

S. Sophia L. Fine-leaved Tansy Mustard. Prosser, **Miss Ruth L. Bennett** 28. A common weed throughout the eastern portion of the state.

Thelypodium integrifolium (Nutt.) Endl. Entire-leaved Thelypodium. Reported from Prosser.

T. laciniatum (Hook.) Endl. Cut-leaved Thelypodium. Rattlesnake Hills, **Cotton** 1109.

CAPPARIDACEÆ. Caper Family

Cleome lutea Hook. Bee Plant. Stinking Mustard. A conspicuous native annual, mustard-like plant with an unpleasant odor, found along roadsides and in dry ground.

CRASSULACEÆ. Orpine Family

Sedum Leibergii Britt. Rattlesnake Hills, elevation 3400 ft., **Cotton** 703.

SAXIFRAGACEÆ. Saxifrage Family

Philadelphus Lewisii Pursh. Syringa. Along the Yakima River between Benton City and Prosser; also in the Rattlesnake Hills. State Flower of Idaho.

Ribes aureum Pursh. Golden Currant. Rattlesnake Hills, **Cotton** 561; **Miss Ruth L. Bennett** 32; along the Yakima River at Prosser, **G. N. Jones**; along the Columbia River at Kennewick, **St. John** 8080. Frequently cultivated.

R. cereum Dougl. Rattlesnake Hills, **Cotton** 559, 560, 553; **Miss Ruth L. Bennett** 22; White Bluffs, **Lake and Hull** 461, **St. John** 8083. Fruit red and juicy but rather tasteless.

Tellima tenella (Nutt.) Walp. Rattlesnake Hills, **Miss Ruth L. Bennett** 5; **St. John** 808. Fruit red and juicy but rather flowers.

ROSACEÆ. Rose Family

Amelanchier Cusickii Fernald. Cusick's Service-berry. Rattlesnake Hills, **Miss Ruth L. Bennett** 15.

A. utahensis Koehne. Utah Service-berry. Rattlesnake Hills, **Cotton** 576, 571, 365; **Miss Ruth L. Bennett** 39. Usually found growing on basaltic ledges.

Crataegus Douglasii Lindl. Black Hawthorn. Hanford, **R. Kent Beattie** 3956; Prosser, **Miss Ruth L. Bennett** 40; Rattlesnake Hills, **St. John** 8098.

Geum triflorum Pursh. Plumed Anemone; Tassels. Rattlesnake Hills, **Cotton** 544.

Purshia tridentata DC. Antelope Brush. A common shrub in rocky ground. Prosser, **G. N. Jones.**

Potentilla biennis Greene. Biennial Cinque-foil. Rattlesnake Hills, **St. John** 8094; Plymouth, **St. John** 8048.

P. Convallaria Rydb. Rattlesnake Hills, **Cotton** 470.

P. millegrana Engelm. Diffuse Cinquefoil. Kennewick, moist ground along the Columbia River, **G. N. Jones** 373; Prosser, **G. N. Jones** 410.

P. viridescens Rydb. Snipes Creek, **Cotton** 662.

Prunus emarginata (Dougl.) Walp. Wild Cherry. White Bluffs, **Lake and Hull**, August 9, 1892. Fruit bright red; juicy and intensely bitter.

P. melanocarpa (A. Nels.) Rydb. Smooth-leaved Choke Cherry. Prosser, **Miss Hazel Evans** 31; Rattlesnake Hills, **St. John** 8097.

Rosa Macounii Greene. Macoun's Rose. In gulches, Rattlesnake Mts., **Cotton** 469; Prosser, **Henderson**, May 26, 1892.

R. Woodsii Lindl. Wood's Rose. River banks, Prosser, **Cotton** 1093, **Miss Ruth L. Bennett** 52.

LEGUMINOSÆ. Pea Family

Astragalus arrectus Gray. Rattlesnake Hills, **Miss Ruth L. Bennett**; Prosser, **Miss Hazel Evans** 22.

A. collinus Dougl. Reported from Hover.

A. glareosus Dougl. Rattlesnake Hills, **Cotton** 552.

A. inflexus Dougl. Has been collected along the Columbia River at Coolidge.

A. Purshii Dougl. Rattlesnake Hills, **Miss Ruth L. Bennett** 23.

A. Spaldingii Gray. Rattlesnake Hills, **Griffiths and Cotton** 3; Prosser, **Cotton** 1108.

A. speirocarpus Gray. Reported from Prosser.

A. succumbens Dougl. Paterson, **Miss Lois E. Mathews,** May 14, 1923. Also reported from Hover.

Glycyrrhiza lepidota Nutt. Wild Licorice. Common along the Yakima River. Prosser, **H. A. Scullen** 44; **G. N. Jones** 352; Richland, **H. E. Willmsen** Oct. 23, 1926. Also reported from Benton City and Kennewick.

Lotus americanus Bisch. Prairie Bird's-foot Trefoil; Spanish Clover. A variable polymorphic species. Gravelly banks of the Yakima River at Prosser, **Cotton** 629; Rattlesnake Hills, **Cotton** 692. A good native forage plant.

Lupinus aridus Dougl. Arid-soil Dwarf Lupine. Hanford, **Beattie** 3947, 3948.

L. aridus Dougl., var. **Torreyi** (Gray) C. P. Smith. Torrey's Lupine. Hanford. **Beattie** 3946.

L. bingenensis Suksd., var. **dubius** C. P. Smith. Bingen Lupine. Prosser (type locality), **Cotton** 1106, Rattlesnake Hills, **Miss Ruth L. Bennett** 41.

L. ornatus Dougl. Ornate Lupine. White Bluffs, **R. Kent Beattie** 3970, 3965; Plymouth, **St. John** 8265.

L. leucophyllus Dougl., var. **Belliae** C. P. Smith. Bell Wooly-leaved Lupine. Rattlesnake Hills, **Cotton** 692; Horse Heaven, **St. John** 8266.

L. pusillus Pursh., var. **intermontanus** (Heller) C. P. Smith. Coolidge, shore of Columbia River, collector unknown; Hanford, **Beattie** 3942.

L. subvexus C. P. Smith, var. **fluviatilis** C. P. Smith. "Sandy soil near river, rare", **Cotton** 912.

Medicago sativa L. Alfalfa. Prosser, **G. N. Jones** 408. The most valuable forage plant of the region, commonly escaped and growing wild along roadsides and in waste ground throughout the irrigated areas; also a good honey plant.

Melilotus alba Desr. White Sweet Clover: White Melilot. Abundant along roadsides and irrigation ditches growing 2-3 meters high. Important as a honey plant.

M. officinalis (L.) Lam. Yellow Melilot. Occasional along roadsides; recently introduced.

Petalostemon ornatus Dougl. Prairie Clover. Sandy flats, Plymouth, **St. John** 8645.

P. ornatus Dougl., forma *pallidus* St. John forma nova. White Prairie Clover. Floribus pallidis. A single bush growing with the magenta-flowered true species, but differing in having whitish flowers. Washington: sandy flats, Plymouth, Benton Co., June 21, 1927, *H. St. John & L. A. Mullen* 8644 (type in Herb. State College of Washington).

Psoralea lanceolata Pursh, var. **scabra** (Nutt.) Piper. Psoralea. Growing in sandy soil. White Bluffs, **R. E. Snodgrass,** July 1903, **A. D. Dunn,** September 16, 1902, **Lake and Hull** 664; Kiona, **Cotton** 723.

Robinia Pseudo-Acacia L. Yellow Locust. Commonly cultivated as a shade tree and occasionally escaping along stream banks and in moist places.

Trifolium hybridum L. Alsike Clover. Fields and roadsides, common.

T. pratense L. Red Clover. Abundant in fields and along roadsides.

T. repens L. White Clover. Common in fields and waste ground.

T. variegatum Nutt. Moist ground, Prosser, **Cotton** 737, 810.

Vicia americana Muhl. Common Vetch. Prosser, **Cotton** 1089; Cold Creek, **Cotton** 399.

V. Cracca L. Tufted Vetch. Roadsides and fields, recently introduced; Prosser, **Miss Hazel Evans** 47.

V. sativa L. Spring Vetch. Fields and waste places; cultivated for fodder.

GERANIACEÆ. Geranium Family

Erodium cicutarium (L.) L'Her. Hemlock Stork's-Bill; Filaree. Frequent in sandy soil; valuable as a forage crop in dry regions, springing up when the ground is moist in the spring and providing excellent forage for all kinds of stock. Rattlesnake Hills, **Cotton** 337; Paterson, **St. John** 8065.

Geranium incisum Nutt. Cut-leaved Geranium. Rattlesnake Hills, **Cotton** 467. Cited in Piper's Flora of Washington as **G. viscosissimum.**

LINACEÆ. Flax Family

Linum Lewisii Pursh. Lewis' Wild Flax. Occosional on hillsides. Rattlesnake Hills, **Cotton** 424; **Miss Ruth L. Bennett** 50; Horse Heaven, **St. John** 8639.

EUPHORBIACEÆ. Spurge Family

Euphorbia glyptsosperma Engelm. Ridge-seeded Spurge. White Bluff Ferry, **Lake and Hull** 641.

CALLITRICHACEÆ

Water-Starwort Family

Callitriche palustris L. Vernal Water-starwort. Along Columbia River at Kennewick, **G. N. Jones** 369.

ANACARDIACEÆ. Sumac Family

Rhus glabra L. Smooth Sumach. Along the Yakima River, Kiona, **Cotton** 729: Prosser, **Cotton** 622. Fruit red, produced in July; neither the fruit nor the foliage poisonous.

ACERACEÆ. Maple Family

Acer Negundo L. Box Elder. Extensively planted, and escaping in some places.

MALVACEÆ. Mallow Family

Malva rotundifolia L. Common Mallow; Cheeses. A frequent weed in waste places, commonly infected with a rust, Puccinia malvacearum. Also an excellent forage plant.

Sphaeralcea Munroana (Dougl.) Spach. Globe Mallow. Prosser, **Henderson**, May 1892, **Miss Ruth L. Bennett** 54; Hover, **C. S. Parker** 643. Has also been collected at Paterson and reported from Kennewick. A very attractive plant with scarlet flowers that appear from May to August; worth cultivating.

HYPERICACEÆ. St. John's-wort Family

Hypericum Scouleri Hook. Scouler's St. John's-wort. Moist ground in the Rattlesnake Hills, **Cotton** 693, **St. John** 8093.

VIOLACEÆ. Violet Family

Viola adunca Smith. var. **glabra** Brainerd. Smooth Hooked Violet. White Bluff Ferry, **Lake and Hull**, August 10, 1892.

V. trinervata Howell. Desert Pansy. Hanford, **Miss Vona M. Gessell**, June 4, 1923.

LOASACEÆ. Loasa Family

Mentzelia albicaulis Dougl. Stick Leaf. Dry sage lands, Horse Heaven, **St. John** 8642.

M. laevicaulis (Dougl.) T. and G. Large-flowered Mentzelia. Prosser, **Cotton** 808; Richland, **H. E. Willmsen**, October 23, 1926. A stout, erect, hoary-pubescent biennial 1-3 m. high, with large yellow flowers; locally abundant in gravelly soil.

CACTACEÆ. Cactus Family

Opuntia polyacantha Haw. Spiny Opuntia; Prickly Pear. White Bluffs, **A. D. Dunn** 203; Kennewick, **Piper**; between Prosser and Benton City, **G. N. Jones**. Very abundant from Plymouth to Paterson.

ONAGRACEÆ. Evening Primrose Family

Boisduvallia stricta (Gray) Greene. Rattlesnake Hills, **Cotton** 690.

Epilobium glandulosum Lehm., var. **adenocaulon** (Haussk.) Fernald. Northern Willow-herb. Snipes Creek, **Cotton** 420; Prosser, **G. N. Jones** 346.

E. angustifolium L. Great Willow-herb; Fireweed. Snipes Creek, **Cotton** 883; frequent along irrigation ditches.

Gaura parviflora Dougl. Small flowered Gaura or Butterfly Weed. Along irrigation ditches, **Cotton** 741.

Oenothera pallida Lindl. White Evening Primrose. Common in sandy soil. White Bluffs Ferry, **R. E. Snodgrass**, July 1903; Hanford, **R. Kent Beattie** 3945; Kiona, **Cotton** 722, **Piper** July 10, 1897; Prosser, **G. N. Jones** 311; Paterson, **Miss Lois E. Mathews**, May 14, 1923. Also reported from Kennewick.

O. strigosa (Rydb.) Mack. and Bush. Evening Primrose. Prosser, **H. A. Scullen** 43, **Cotton** 620. Also reported from Benton City.

Sphaerostigma contortum (Dougl.) Walp. Coolidge, collector unknown.

UMBELLIFERÆ. Parsley Family

Anethum graveolens L. Dill. Introduced from Europe. Seeds and foliage sometimes used for flavoring. Kennewick, moist ground along the Columbia River, **G. N. Jones** 377; Prosser, cultivated ground, **G. N. Jones** 419.

Apium graveolens L. Celery. Kennewick, moist ground along Columbia River, **G. N. Jones** 378. It was determined by Dr. J. N. Rose. This collection differs in appearance and in several technical points from the cultivated celery. More material may yet prove this to be distinct.

Carum Gairdneri (H. and A.) Gray. Saweet. Grassy hillside; roots of this plant were formerly used extensively by the Indians for food. White Bluff Ferry, **Lake and Hull**, August 1, 1892; Rattlesnake Hills, **Cotton** 661.

Cicuta occidentalis Greene. Poison Parsnip; Western Water-hemlock. Common along irrigation ditches; root poisonous. Prosser, **G. N. Jones** 334.

Daucus Carota L. Carrot. An occasional weed in cultivated ground. Reported from Benton City.

Leptotaenia dissecta Nutt. Cut-leaved Parsley. Rocky hillsides, Rattlesnake Hills, **Cotton** 332.

Lomatium Canbyi C. and R. Canby's Lomatium. Rattlesnake Hills, **Cotton** 567.

L. Gormani (Howell) C. and R. Pepper and Salt. Rocky ridges in the Rattlesnake Hills, **St. John** 8090. One of the first plants to bloom in the spring.

L. Grayi C. and R. Gray's Lomatium. Moist, rocky hillsides, plant malodorus; Prosser, **G. N. Jones** 411; Coolidge, collector unknown; Hanford, along Columbia River, **St. John** 8118; White Bluffs, **Beattie** 3960.

L. macrocarpum (Nutt.) C. and R., var. **artemisiarum** Piper. Large-fruited Lomatium. Growing in gravelly sagebrush land. Type locality; Pasco, Franklin Co. Prosser, **Cotton** 1074b, 1101, 588, **Henderson** 2510; Rattlesnake Hills, **Cotton** 564; Coolidge, **St. John** 8074; White Bluffs, **Beattie** 3961.

L. triternatum (Pursh) C. and R. Grassy slopes, Rattlesnake Hills, **St. John** 8082.

Pteryxia terebinthina (Hook.) C. and R. Sagebrush Parsley. A common spring plant, usually growing in rocky soil; plant with a strong odor. Prosser, **Cotton** 1080: Barrel Springs, **Griffiths and Cotton** 39: Hanford, **St. John** 8111; Paterson, gravelly beach of the Columbia River, **St. John** 8071; Cold Creek, **St. John** 8130.

PRIMULACEÆ. Primrose Family

Dodecatheon Cusickii Greene. Rattlesnake Hills, **Cotton** 357, **Miss Ruth L. Bennett** 14.

GENTIANACEÆ. Gentian Family

Centaurium exaltatum (Griseb.) St. John Tall Centaury. Rattlesnake Hills, **Cotton** 665; Prosser, **Cotton** 658. A slender annual, with sessile, opposite, entire leaves and pink flowers, growing in moist places.

ASCLEPIDACEÆ. Milkweed Family

Asclepias speciosa Torr. Woolly Milkweed. Prosser, **H. A. Scullen** 41. Plentiful along the Yakima River between Prosser and Benton City. A stout perennial 2-3 meters high with milky juice, opposite leaves 10-15 cm. long and large, showy flowers.

COLVOLVULACEÆ
Morning-glory Family

Convolvulus arvensis L. Field Bindweed Becoming a serious weed in some sections of the county; native of Southern Europe.

Cuscuta epithymum Murray. Alfalfa Dodder. Prosser, growing on clover, **G. N. Jones** 388.

C. pentagona Engelm., var. **calycina** Engelm. Field Dodder. Prosser, **G. N. Jones** 341, on Alfalfa, 405, on Achillea and Grindelia; Richland, on Alfalfa, **G. N. Jones** 330.

POLEMONIACEÆ. Phlox Family

Collomia grandiflora Dougl. Salmon-flowered Collomia. Gravelly soil, Prosser, **Cotton** 1083.

C. linearis Nutt. Slender-leaved Collomia. Paterson, collector unknown.

Gilia inconspicua (Smith) Dougl. Small-flowered Gilia. Horse Heaven Hills, **Cotton** 591; Hanford, banks of the Columbia River, **R. Kent Beattie** 3591.

Gilia humilis (Greene) Piper. Dwarf Gilia. Rattlesnake Hills, **Cotton** 308; dry ground among the sagebrush, 15 miles west of Hanford, **St. John** 8128.

G. minutiflora Benth. Small blue-flowered Gilia. Dry sandy soil, Kiona, **Piper** 2755: Prosser, **G. N. Jones** 331; **Cotton** 813, "a characteristic weed of the worn-out range."

G. pharnaceoides Hook. Rattlesnake Hills, common, **Cotton** 473. A common, much branched little plant on dry gravelly hillsides.

Navarretia propinqua Suksd. Rattlesnake Hills, dry gravelly soil in canyons. **Cotton** 663. Cited in Piper's Flora of Washington as **N. intertexta** but has been re-named by Mr. Suksdorf as this.

Phlox canescens T. and G. Hoary Phlox. Horse Heaven, **Cotton** 589; Rattlesnake Hills, **Cotton** 347, 566, **Miss Ruth L. Bennett** 18.

P. longifolia Gray. Long-leaved Phlox. Horse Heaven Hills, **Miss Ruth L. Bennett** 25; Rattlesnake Hills, **Cotton** 348.

P. Whitedii E. Nels. Whited's Phlox. Rattlesnake Hills, **Cotton** 573.

Polemonium micranthum Benth. Small-flowered Polemonium. Paterson, **St. John** 8063.

HYDROPHYLLACEÆ. Waterleaf Family

Conanthus parviflorus Greenm. Small-flowered Conanthus. Kennewick, in drifting sand, **Piper**, July 10, 1897.

Phacelia leucophylla Torr. White Phacelia. Rattlesnake Hills, **Griffiths and Cotton** 26; Prosser, **G. N. Jones** 413; has also been reported from Kennewick.

P. linearis (Pursh) Holz. Narrow-leaved Phacelia. Rattlesnake Hills, **Cotton** 330: has also been collected at Paterson and reported from Hover.

BORAGINACEÆ. Borage Family

Amsinckia arenaria Suksd. Tarweed. Paterson, along railroad, April 22, 1910, **W. H. K.**

A. tessellata Gray. Horse Heaven, dry hills, 10 miles sw. of Kennewick, **St. John** 8643.

Coldenia Nuttallii Hook. Coldenia. Sandy ground, Kennewick, **Piper,** July 10, 1897; **Warren** 541.

Cryptantha ambigua (Gray) Greene. Rattlesnake Hills, **Griffiths and Cotton** 24; Horse Heaven, **St. John** 8641.

C. circumscissa (H. & A.) Johnston, var. genuina Johnston. Dry sands, Kennewick, **Warren** 540.

C. Hendersoni (Nels.) Piper. It has been collected at Coolidge. This variant with a single nutlet with a loose smooth shining testa is included in the species **Hendersoni** by Dr. I. M. Johnston. It has been separated as **C. grandiflora** Rydb.

C. leucophaea (Dougl.) Payson. It has been collected on the Horse Heaven, and reported from Kennewick.

C. Macounii (Eastw.) Payson. Rattlesnake Hills, rocky ground, **Cotton** 359.

Heliotropium curassavicum L. Heliotrope. An abundant weed along roadsides and in alkaline fields at Kennewick. **G. N. Jones** 356. Has also been reported from Hover.

Hackelia arida (Piper) Johnston. Sagebrush Stick-seed. Gravelly north hillsides in the Rattlesnake Hills,. **Cotton** 360, 579, 650.

Lappula Redowskii (Hornem.) Greene, var. **occidentalis** (Wats.) Rydb. Western Stick-seed. Rattlesnake Hills, **Cotton** 407; Prosser, **Cotton** 1091.

Lithospermum ruderale Dougl. Cat's-tooth; Lemon-weed. Common on hillsides. Rattlesnake Hills, **Cotton** 358; Horse Heaven, **St. John** 8053.

Mertensia foliosa A. Nels., var. **subcalva** (Piper) Macbr. Leafy Western Bluebell. Rattlesnake Hills, **Cotton** 328. This is from the type locality.

M. longiflora Greene, var. **pulchella** (Piper) Macbr. Long-flowered Western Bluebell. Rattlesnake Hills, **Miss Ruth L. Bennett** 7.

Pectocarya pencillata (H. & A.) A. DC. Rattlesnake Hills, **Griffiths and Cotton** 22.

VERBENACEÆ. Vervain Family.

Verbena bracteosa Michx. Bracted Verbena. A very common native weed in waste places and cultivated ground. Prosser, **H. A. Scullen** 37; **G. N. Jones** 378; **C. S. Parker** 653.

V. hastata L. Blue Vervain. Moist ground along roadsides, introduced recently and not yet very common. Has been observed at Benton City.

LABIATÆ. Mint Family

Lycopus lucidus Turcz. Northwest Water Hoarhound. Prosser, **G. N. Jones** 379, plentiful along irrigation ditches.

Marrubium vulgare L. Horehound. A common introduced weed. Prosser, **H. A. Scullen** 38; Benton City, **G. N. Jones.**

Mentha arvensis L., var. **lanata** Piper. Woolly Field Mint. Common along irrigation ditches. Prosser, **G. N. Jones** 324.

M. arvensis L., var. **canadensis** (L) Briquet. American Wild Mint. Prosser, **Cotton** 654; Rattlesnake Hills, **Cotton** 699.

M. spicata L. Spearmint. Naturalized about old gardens. Observed at Benton City, **G. N. Jones.**

Monardella odoratissima Benth., subsp. **discolor** (Greene) Epling. Coyote Mint. White Bluffs Ferry, **Lake and Hull** 705; Rattlesnake Hills, **Cotton** 760; **St. John** 8089.

Nepeta Cataria L. Catnip. Introduced in waste ground. Prosser, **H. A. Scullen** 40.

Ramona incana (Benth.) Dougl. Ball Sage; Purple Sage. Growing in patches in rocky ground, common. Rattlesnake Hills, **Cotton** 467, 388; **Griffiths and Cotton** 25; Prosser, **H. A. Scullen** 44; **G. N. Jones** 321.

Scutellaria lateriflora L. Prosser, along irrigation ditches, **G. N. Jones** 380.

SOLANACEÆ. Nightshade Family

Lycium chinense Mill. Matrimony Vine. Prosser, **G. N. Jones** 350. A climbing shrub with slender arching, light-colored branches, alternate, entire, ovate leaves and 5-parted purple flowers, 5 mm. broad; often persisting about old gardens and may be found occasionally throughout the irrigated sections.

Nicotiana attenuata Torr. Wild Tobacco. Rattlesnake Hills, **Cotton** 477. The native wild tobacco of the region formerly cultivated by the Indians.

Solanum Dulcamara L. Bittersweet: Nightshade. Climbing over bushes along the Yakima River, introduced, Benton City, **G. N. Jones.**

S. luteum Mill. A common weed in cultivated ground and along irrigation ditches. Prosser, **G. N. Jones** 332.

S. nigrum L. Common Nightshade. Common; reported from Hover, Kennewick, and Benton City.

S. triflorum Nutt. Three-flowered Nightshade. Very common throughout the irrigated sections. Prosser, **G. N. Jones** 323. Has been reported from Hover, Paterson, Kennewick and Benton City.

SCROPHULARIACEÆ. Figwort Family

Castilleja pallescens (Gray) Greenm. Indian Paint-brush. Prosser, **Cotton** 1082. 1102; Rattlesnake Hills, **Cotton** 671.

Collinsia tenella (Pursh) Piper. Common on hillsides. Rattlesnake Hills, **Cotton** 327; moist ground, Hanford, **St. John** 8119.

Limosella aquatica L. Mudwort. Gravelly beach of the Columbia River at Paterson, **St. John** 8062.

Mimetanthe pilosa (Benth.) Greene. Bottoms of canyons, Rattlesnake Hills. **Cotton** 880; **Cotton** 911.

Mimulus ampliatus Grant. Monkey-flower. Moist gravelly soil, Prosser, **Cotton** 651.

M. fioribundus Dougl. Many-flowered Mimulus. Snipes Creek, **Cotton** 418 in part.

M. guttatus DC. Prosser, **G. N. Jones** 385; Kennewick, **G. N. Jones** 364; Snipes Creek, **Cotton** 417; Cold Creek, **Cotton** 394.

M. washingtonensis Gdgr. Suksdorf's Mimulus. Prosser, **Cotton** 418 in part.

Penstemon acuminatus Dougl. Sharp-leaved Penstemon Horse Heaven, **Leckenby**, May 1898; Coolidge, collector unknown; Richland, **Beattie** 3934; Hanford, **Beattie** 3943, 3944; **St. John** 8115.

P. glaber Pursh. Smooth Penstemon. Rattlesnake Hills, **Miss Ruth L. Bennett** 51.

Scrophularia lanceolata Pursh. Rattlesnake Hills, **St. John** 8084.

Verbascum Thapsus L. Common Mullein. A common weed in waste ground. Benton City, **G. N. Jones**; Rattlesnake Hills, **Cotton** 479.

Veronica americana Schwein. American Water-speedwell. Cold Creek, **Cotton** 396.

Veronica peregrina L., var. *xalapensis* (H. B. K.) St. John and Warren, comb. nov. *V. xalapensis* H. B. K., Nov. Gen. et Sp. 2: 389. 1818; *V. peregrina xalapensis* (H. B. K.) Pennell, Torreya 19: 167. 1919. As Dr. Pennell has clearly indicated, this plant with the glandular pubescence completely replaces the glabrous *V. peregrina* L. in western North America. In his discussion he makes clear that, "Intergradation to the species seems to be complete." This is exactly our understanding of a variety. In order to have an available name under the International Rules, we make the varietal combination. Gravelly beach of the Columbia River at Hanford, *St. John* 8120; Plymouth, *St. John* 8049; Paterson, *St. John* 8069.

OROBANCHACEÆ. Broom-rape Family

Orobanche comosa Hook. Broom-rape. Rattlesnake Hills, **Cotton**, 764.

PLANTAGINACEÆ. Plantain Family

Plantago lanceolata L. Buckhorn; Ribwort Plantain: An introduced weed in lawns and waste places. Benton City, **G. N. Jones.**

P. major L. Common Plantain. A common weed in waste ground; probably not native.

P. Purshii R. and S. Pursh's Plantain. A common native plant occuring in dry ground, especially on the worn-out ranges. Used as forage in some parts of Okanogan Co., Wash. Rattlesnake Hills, **Cotton** 392; White Bluffs, **R. Kent Beattie** 3966. Has also been collected at Paterson and reported from Kennewick.

RUBIACEÆ. Madder Family

Galium multiforum Kellogg, var. *berulum* (Piper) St. John, comb. nov. *G. multiflorum*,, subsp. *puberulum* Piper, Contr. U. S. Nat. Herb. 11: 527. 1906. This differs from the Californian var. *hirsutum* Gray, in having the herbage puberulent, instead of hirsute. It seems better, as it differs only in the nature of its pubescence, to treat this plant also as a variety. Rattlesnake Hills, *Cotton* 696.

CAPRIFOLIACEÆ. Honeysuckle Family

Sambucus caerulea Raf. Tree Elder. Occasional in canyons in the Rattlesnake Hills, **Cotton** 757.

Symphoricarpos albus (L.) Blake. Snowberry. Rattlesnake Hills, **Cotton** 694.

VALERIANACEÆ. Valerian Family

Aligera Grayi Suksd. Corn Salad. Dry ground, among sage-brush, Rattlesnake Hills, **Cotton** 335; **Miss Ruth L. Bennett** 33; Paterson, **St. John** 8064. Reported also from Hover.

COMPOSITÆ. Aster Family

Achillea lanulosa Nutt. Yarrow or Milfoil. Prosser, **Miss Ruth L. Bennett** 49: Coolidge, collector unknown; also reported from Richland.

Agoseris heterophylla (Nutt.) Greene. Variable Goat Chicory or Western Dande-

lion. Prosser, in dry, sandy soil, **Cotton** 638; Coolidge, along the shore of the Columbia River, collector unknown.

Ambrosia artemisiaefolia L. Roman Wormwood. Prosser, **G. N. Jones** 312. A weed in dry soil in the irrigated areas.

Antennaria confinis Greene. Rattlesnake Hills, **Cotton** 1280.

A. dimorpha T. and G. Rattlesnake Hills, **Cotton** 309; **St. John** 8099, 8085.

Artemisia Dracunculus L., ssp. **typica** Hall and Clements. Dragon Sagewort. Prosser, **G. N. Jones** 349.

A. tridentata Nutt. Common Sagebrush. The most abundant and conspicuous plant of the Upper Sonoran Zone and by far the most abundant plant in the county; grows 1-2 meters high; valuable in winter for grazing purposes; the pollen of this plant is one of the producers of hay-fever. Occasionally cultivated. Rattlesnake Hills, **A. D. Dunn**, September 10, 1902; Prosser, **G. N. Jones** 353.

A. tridentata Nutt., ssp. **trifida** (Nutt.) Hall and Clements. (A tripartita Rydb.) Rattlesnake Hills, **Cotton** 482.

A. vulgaris L., ssp. **ludoviciana** (Nutt.) Hall and Clements. Common Sagewort. Prosser, **C. S. Parker** 652.

Aster canescens Pursh, var. **viscosus** (Nutt.) Gray. Dry ground, common and becoming a weed in the irrigated areas. Rattlesnake Hills, **Cotton** 478, 884; Prosser. **G. N. Jones** 320.

Balsamorhiza Careyana Gray. Spalding's Balsam-root. A common, showy, spring-blooming, desert plant. Rattlesnake Hills, **Cotton** 336; Prosser, **Griffiths and Cotton** 10,**Cotton** 1084, 1105; Hanford, dry ground among the sage-brush, common, **St. John** 8116; Horse Heaven, **St. John** 8052.

B. rosea Nels. and Macbr. Pink Balsam-root. Rattlesnake Hills, **Cotton** 568, the type locality.

Bidens cernuua L. Nodding Bur-marigold. Kennewick, moist ground along the Columbia River, **G. N. Jones** 376.

B. vulgata Greene. Five-leaved Bur-marigold. Reported from Kennewick.

Blepharipappus glandulosus Hook. Hanford, **R. Kent Beattie**, 3954; White Bluffs, **R. Kent Beattie** 3962; Rattlesnake Hills, **Miss Ruth L. Bennett**; Paterson, collector unknown.

Brickellia oblongifolia Nutt., var. **typica** Robinson. Thoroughwort. Rattlesnake Hills, **Cotton** 710.

Centaurea repens L. An introduced European weed which spreads by deep-seated rhizomes as well as by seed. First recorded for this state in 1920 in Okanogan Co. Now spreading rapidly and becoming a serious weed in some places. Prosser, **G. N. Jones** 337.

Chaenactis Louglasii (Hook.) H. and A. Hanford, **R. Kent Beattie** 3953; Prosser, **Cotton** 1097; **G. N. Jones** 408. Also reported from Kennewick.

Cichorium Intybus L. Chicory. A common roadside weed in the irrigated districts, native of Europe. Flowers closing shortly after noon. Roots sometimes used as a substitute for coffee. Benton City, **G. N. Jones.**

Chrysothamnus nauseosus (Pallas) Britt., ssp. **speciosus** (Nutt.) Hall and Clements. Fetid Rabbit-brush. White Bluffs, **A. D. Dunn**, September 13, 1902; Prosser, **G. N. Jones** 339; **Cotton** 897, 898; Rattlesnake Hills, **Cotton** 481.

C. viscidiflorus (Hook.) Nutt., ssp. **lanceolatus** (Nutt.) Hall and Clements, Rattlesnake Hills, very common, **Cotton** 476; **G. N. Jones** 455.

C. viscidiflorus (Hook.) Nutt., ssp. **pumilus** (Nutt.) Hall and Clements. Rattlesnake Hills, **A. D. Dunn**, September 10, 1892.

Cirsium arvense Scop. Canada Thistle. Becoming established in several places in the county. Prosser, **G. N. Jones.**

C. lanceolatum Scop. Bull Thistle. Abundantly introduced in fields and along road-sides.

C. undulatum (Nutt.) Spreng. Wavy-leeaved Thistle. A very handsome species, growing about one meter high with pink, or occasionally white, flowers 6-8 cm. in diameter. Rocky hillsides in the Rattlesnake Hills, **Cotton** 712; **St. John** 8092.

Coreopsis Atkinsoniana Dougl. Coreopsis or Tickseed. Moist ground along river-banks. Hover, **C. S. Parker** 650; Richland. **G. N. Jones** 329.

Crocidium multicaule Hook. Coolidge, abundant. An attractive little annual, spring-flowering plant with yellow flowers 1-2 cm. broad, often covering large areas. In the vicinity of Coolidge the sandy cactus flats are yellow with this plant in the spring. **St. John** 8075.

Erigeron canadensis L. Horse-weed. A very abundant native weed in irrigated ground. Prosser, **Cotton** 886; Benton City, **G. N. Jones.**

E. concinnus T and G. Hairy Erigeron. Common in dry ground. Rattlesnake Hills, **Cotton** 403; Prosser, **Cotton** 1095.

E. corymbosus Nutt. Corymbed Erigeron. Rattlesnake Hills, **Cotton** 689.

E. curvifolius Piper. Curved-leaved Erigeron. Prosser, **Cotton** 1100, 1075b.

E. filifolius (Hook.) Nutt. Slender-leaved Erigeron. Rattlesnake Hills, in rocky soil, **Cotton** 701, 363.

E. linearis Nutt. Linear-leaved Erigeron. Gravelly soil, common. White Bluff Ferry, **Lake and Hull**, August 9, 1892.

E. poliospermus Gray. Howell's Erigeron. Dry, rocky soil, common. Rattlesnake Hills, **Cotton** 331; Horse Heaven Hills, **Cotton** 586.

Eriophyllum multiflorum (Nutt.) Rydb. Woolly Yellow Daisy. Rattlesnake Hills, **Miss Ruth L. Bennett; Cotton** 405. Fairly common in dry ground.

Franseria acanthicarpa (Hook.) Cov. Sand-bur. In sandy soil along river-banks. Prosser, **Cotton** 630. Also reported from Kennewick.

Gaillardia aristata Pursh. Gaillardia. White Bluffs, **R. Kent Beattie** 3959; Kiona, **Cotton** 731; Prosser, **Cotton** 626; Paterson, collector unknown.

Gnaphalium chilense Spreng. Chamisso's Cudweed. River-banks and along irrigation ditches. Prosser, **Cotton** 896; **G. N. Jones** 327.

Grindelia nana Nutt., var. **discoidea** Gray. Gum-weed. White Bluff Ferry, **Lake and Hull**, August 11, 1892; Kennewick, **G. N. Jones** 354; Prosser, **G. N. Jones** 404.

Haplopappus stenophyllus Gray. Rattlesnake Hiils, **Miss Ruth L. Bennett** 36; **Cotton** 346.

Helenium autumnale L. Sneezeweed. Hover, **C. S. Parker** 651.

Helianthus annuus L. Common Sunflower. Common along roadsides in the irrigated districts. Benton City, **G. N. Jones.**

Hieracium griseum Rydb. Hawkweed. Rattlesnake Hills, **Cotton** 677.

Hymenopappus filifolius Hook. Prosser, **G. N. Jones** 325.

Lactuca scariola L., var. **integrata** Gren. and Godr. Prickly Lettuce; China Lettuce. A common weed in waste ground and along roadsides; flowers closing after 9 A. M.

L. pulchella (Pursh) DC. Blue-flowered Lettuce. A troublesome weed in some places but not yet very common in Benton Co. Prosser, **H. A. Scullen** 39.

Nothocalais troximoides (Gray) Greene. Western Dandelion. Rattlesnake Hills, **Cotton** 323; Horse Heaven Hills, **Cotton** 585.

Senecio flavovirens Rydb. Yellow Ragwort. White Bluffs, **Beattie** 3963.

S. hydrophilus Nutt. Smooth-leaved Ragwort. In swampy ground along the Columbia River at Kennewick, **G. N. Jones** 371.

S. serra Hook. Serrate-leaved Ragwort. Rattlesnake Hills, **Cotton** 675.

Solidago elongata Nutt. Prosser, along irrigation ditches, **G. N. Jones** 397.

S. missouriensis Nutt. Missouri Goldenrod. Rattlesnake Hills, **Cotton** 480; **St. John** 8091.

S. occidentalis T and G. Western Goldenrod. Very common along roadsides and irrigation ditches. Prosser, **Cotton** 887, **G. N. Jones** 345.

S. serotina Ait. Late-flowering Goldenrod. Along the Yakima River at Prosser. **Cotton** 811.

Sonchus oleraceus L. Sow-thistle. Occasional in fields and waste places.

Stephanomeria paniculata Nutt. Panicled Flowering-straw. White Bluff Ferry, **Lake and Hull** 690.

S. tenuifolia (Torr.) Hall. Narrow-leaved Flowering-straw. White Bluff Ferry, **Lake and Hull** 812.

Taraxacum vulgare (Lam.) Schrank. Common Dandelion. Common throughout the irrigated areas. Prosser, **Miss Ruth L.**

Fig. 4.—Xanthium aridum St. John, n. sp., drawn from the type.
Leaf X1; Fruit X4; Spine X14

Bennett 42; Paterson, gravelly beach of the Columbia River, **St. John** 8070; moist ground along roadside at Hanford, **St. John** 8127.

Tanacetum vulgare L. Tansy. Found occasionally along roadsides as a garden escape. Prosser, **G. N. Jones** 414.

Tetradymia canescens DC. Rattlesnake Hills, **Cotton** 695.

Townsendia florifer Gray. Townsendia. Hanford, **R. Kent Beattie** 3955; Rattlesnake Hills, **Miss Ruth L. Bennett** 44; Prosser, **Cotton** 1094; opposite Umatilla, **Howell** April 20, 29, 1882.

Xanthium italicum Mor. Cocklebur. Prosser, **G. N. Jones** 401. The eating of the young plants of various species of cocklebur by stock, especially pigs, has frequently resulted in poisoning. (U. S. D. A. Bull. 1274; 1924).

Xanthium aridum St. John, n. sp. Stem stout, pulvinate hispid above, sparsely so below, fastigiate branched, 2-5 dm. high; leaves deltoid-cordate with two shallow rounded lateral lobes, unevenly dentate, harshly scabrous on both sides with small appressed pulvinate hispid hairs, including the petiole about 8 cm. long, the petiole shorter than the blade; body of the fruit ellipsoid, 8-12 mm. long, 5-6 mm. thick, densely covered with fine hooked prickles, glandular hispid; beaks with smooth slender tips, glandular hispid below, incurved, 2.5-3.5 mm. long; prickles fine and numerous, glandular hispid below, glabrous and hooked at the tips, brown in color like the rest of the fruit, 2-3.5 mm. long.

Foliis deltoideocordatis, corpibus fructuum ellipsoideis 8-12 mm. longis, rostris 2-3.5 mm. longis.

This new plant from a sheltered canyon on the slopes of the bleak arid Rattlesnake Hills is most closely related to *X. pennsylvanicum* Wallr., but that species differs in having: leaves often acutely 3-5-lobed, 7-20 cm. long; body of the fruit 1-2 cm. long, 5-8 mm. thick; beaks 4-6 mm. long; prickles 3-7 mm. thick.

Washington: gravel benches in Black Canyon, 2400 feet altitude, Rattlesnake Hills, April 8, 1927, *H. St. John, C. English, G. N. Jones, and L. A. Mullen* 8100 (type in Herb. State College of Washington).

All of the specimens observed were of the previous season's growth, showing full grown stems, shriveled leaves, and abundant ripe fruit.

List of New Plants Described In This Catalog

Puccinellia Suksdorfii St. John
Eleocharis monticola Fern., var. *pallida* St. John
Petalostemon ornatus Dougl., forma *pallidus* St. John
Veronica peregrina L., var. *xalapensis* (H. B. K.) St. John and F. A. Warren
Galium multiflorum Kell., var. *puberulum* (Piper) St. John
Xanthium aridum St. John

Tabular Summary

	Families	Genera	Species
Pteridophyta	3	4	6
Gymnospermae	1	2	3
Monocotyledones	10	44	86
Dicotyledones	47	72	308
TOTALS	61	122	403

Number of indigenous species.....320
Number of adventive species..... 83

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Heart Pain

CHARLES M. ANDERSON, M.D.

Heart pain may be of two types: *Organic,* that is, in the heart itself, or *Functional,* that is, outside the heart muscle. In the organic we find it chiefly in angina pectoris, aneurysm and aortic insufficiency, and less frequently in other forms of endocarditis, myocarditis, cardiac dilitation and pericarditis. If not organic, it may be due to digestive disturbances, such as distention of stomach or colon, absorption of toxins from constipation, or over-indulgence in tobacco or coffee. In patients with functional psychosis, in neurotic individuals and at the menopause, the heart pain may be severe. It is one of the usual complaints in effort syndrome or nervous heart. The functional type is more common in women and may occur at all ages.

When a healthy person runs until his heart becomes exhausted, he is compelled to desist by breathlessness, or a sensation of oppression across the chest, sometimes accompanied by pain. Pain can arise from any muscle in health when that muscle is made to contract to an excessive degree, or is forced to continue working after fatigue is produced. When pain arises in a muscle affected by disease, the symptom is produced in the same manner as in health, only the exhaustion, of which it is the evidence, is more readily induced and in the pain, therefore, appears with greater facility in diseased muscles.

If it is appreciated that the pain in heart affections is but a symptom, which is capable of being evoked in all hearts, the only difference between its appearance in health and disease being the greater ease by which it is produced in the diseased heart, a good idea is obtained of the seemingly intricate and complicated phenomena which we call angina pectoris or heart pain, and which can therefore be looked upon as an expression of exhaustion of the heart muscle. With this conception in mind we are put on a track which leads to a clear view of the patient's condition. If in health, exhaustion from over-exertion induces pain, in impaired health with a weakened heart muscle, if pain is easily induced, we are led to inquire into the cause of the premature exhaustion. In people who suffer from any debilitating state, the heart likewise suffers, and consequently in them we may get heart pain readily induced. Although the heart pain may be a dominant symptom, if we recognize that the heart condition from which it arises is provoked from some other source, we are at once directed to search for causes that may tend to debility. When extraneous causes of cardiac debility can be excluded, consideration is given to the state of the heart, as naturally a disease of the heart which impairs its functional efficiency will be apt to induce pain. Here, however, we are met with a difficulty. If a number of patients be examined who present different symptoms and their hearts are examined after death, diseases seemingly identical may be found present in the heart. Thus the coronary arteries may be found diseased with degenerative changes in the heart's muscle. During life, pain was the chief symptom in a few, while others suffered no pain. In cases of aortic disease, pain is sometimes a clamant symptom, while in others pain never occurs. In the hypertrophied heart associated with kidney disease, pain is occasionally a very distressing symptom, while in others no pain is felt.

That these differences should bewilder and confuse and lead to a great many theories as to the cause of pain in heart disease, is but natural, and we have many people who strenuously support this or that view, and each supplies many facts which he claims supports his view. Some indeed would refer the pain to the state

of the nervous system, some patients having a nervous system more susceptible to pain than others, and they have no difficulty in getting facts to support such a view.

At this stage of knowledge it would be unprofitable to enter into a discussion of the subject. The view that pain is an expression of exhaustion of the heart muscle, gives the best idea of the nature and extent of the heart's impairment in grave affections of the heart as in milder affections. The association of angina pectoris or heart pain with diseases of the coronary arteries is so well recognized that some take it as an evidence of coronary disease, and the pain is supposed in some way to actually be produced by the artery itself. If, on the other hand, we look upon the disease of the artery as preventing an adequate supply of blood to the heart muscle, so that exhaustion of the heart is brought about very speedily when effort is made, a better idea is formed of the nature of the complaint. Experiments have shown that when the heart is made to increase its work, the coronary arteries dilate and supply the heart muscle with a greatly increased supply of blood. If disease of the coronary arteries prevents this increased supply, we can understand that the exhaustion of the heart muscle becomes readily produced. In certain people the degree of effort the heart is forced to make corresponds to the frequency and severity of attacks of pain.

When pain or other evidence of sensory disturbances are present, the conception of an exhausted heart at once arises. This puts us on a track to find out the causes of exhaustion; whether the circumstances and environment of the patient's life give occasion for exhaustion, as overwork, worry, sleeplessness, poor food; or whether any condition is present which lowers the vitality, as toxic influences from bacterial infections, intestinal stasis, diseases of other organs; or whether there is an obscure disease of the heart as shown by certain physical signs as the presence of valve defects which embarrass the heart in its work; or whether there is kidney disease with arterial resistance causing high blood pressure or other changes that hamper the heart and tend toward exhaustion. Lastly, there are the changes frequently found in the coronary arteries, associated with advancing years, in people in whom there are no perceptible signs of heart disease, either in the size or rhythm of the heart or the sounds of the heart. Here a mechanical aid, the electrocardiograph helps in diagnosis. Confirmatory evidence of a diminished capillary field are often found in the thin and atrophied skin together with the thickened radial artery, from which it can be inferred that similar changes have taken place in the arteries of the heart, with a consequent diminished supply of blood to the heart.

The region in which cardiac pain is felt is a very characteristic one, being usually in the left side of the chest. It frequently spreads to the inner side of the upper arm and forearm. This region corresponds to the peripheral distribution of the lower cervical nerves (6th and 7th in the arm) and the upper three or four dorsal nerves (in the upper arm and the chest). When pain occurs in any part of these regions, the question of its being of cardiac origin should arise. In some the pain may radiate to similar regions in the right side, and in rare instances the pain is wholly right sided. In a few cases the pain may also be felt behind the lower jaw and behind the ears.

The starting of the pain is usually across the chest, about the level of the third ribs, or as low as the fifth ribs. It may, however, arise in any part of the left side of the chest or in the upper or lower left arm. When it starts in the chest it may remain fixed there but usually it spreads across the chest and

into the left arm. If it arises in the arm, it spreads to the chest. After it radiates, it remains fixed for a shorter or longer period with greater severity in one place, either in the chest or in the arm.

The duration may be for a few seconds, yielding at once on the cessation of some provoking cause, or it may remain for a few minutes or last with slight variation of intensity for many hours. A dull aching, not of much severity, may be present off and on for days. An increased sensitiveness to pain (hyperalgesia) in the area of the skin over and around the left breast is often present in women. The patient is sometimes conscious of this tenderness and any pressure hurts, as when the clothing is rather tight.

Associated with the attacks of pain are other reflexes; the most frequent and the most instructive is the sense of *"constriction of the chest."* This may be limited to a slight uneasiness across the chest and it may never get beyond that. Frequently this slight uneasiness gradually increases until the chest is held as if in a vise and the sensation, because of its severity, carries with it a sense of fear. It is independent of the pain and may be present without the characteristic pain, though both sensations are often combined. In a large proportion of cases liable to severe attacks of pain as a result of effort, the first sign that the heart is becoming exhausted, is a slight sense of constriction. When this occurs while walking, if the patient slows his gait or stops, the sensation at once disappears. If, on the other hand, he ignores the sensation and tries to "walk it off," it increases in severity and the pain appears and the consequent suffering becomes so great that the patient is compelled to stop. This severe stage may not be reached in the early days of the appearance of the signs, but if neglected, the exhaustion of the heart gradually increases until its neglect is followed by the greatest distress.

Accompanying this sensation of constriction, there is frequently a sense of *suffocation,* a feeling as if the throat were being compressed, referred to the neck immediately above the sternum.

Other reflexes produced at the same time as the pain are occasionally present, as *a flow of saliva and increased urine excretion.* There is also often present that *sense of collapse allied to shock,* which results from a violent stimulation reaching the central nervous system by way of the cardiac sympathetic nerve.

Pain and the other reflex phenomena appear in many kinds of heart affections, from those suffering from gross disease to others with healthy hearts temporarily exhausted.

Recognizing that pain may arise from hearts affected by disease and in hearts in which there is no structural lesion, but where the muscle is weakened by influences which produce exhaustion, as overwork, poisoning, or impaired nutrition, we obtain a division which not only serves for a discussion of the subject, but when the differences are appreciated, places us in a position to diagnose correctly the great bulk of cases. These two groups will be discussed under the headings of: (A) Angina Pectoris from Diseased Hearts, and (B) Angina Pectoris due to Toxic and Debilitiating Causes.

A. *Angina Pectoris In Diseased Hearts*

The tragic circumstances associated with certain forms of angina pectoris have so impressed the medical profession, as well as the general public, that any suggestion of the presence of such a condition conveys with it a sense of grave danger. That there are cases in which the occurrence of pain indicates a serious state is undoubted, but if it is understood that the pain is but an expression of exhausted muscle and that, in the vast majority of sufferers, the exhaustion is not due to any serious form of disease, a truer appreciation of the condition will be obtained. Nor must the estimation

of the gravity of any given case be based upon the degree of suffering, for a severe attack of pain is not necessarily dangerous, nor are the mildest attacks free from a dangerous significance. The importance of the symptoms must be estimated by an examination of the conditions that have provoked the exhaustion of the heart muscle. To recognize that, Sir James McKenzie has analyzed the records of many hundreds of cases. The division of the cases into the following groups affords a means of presenting the essential features of the great majority of cases:

(1) People in advanced life, about fifty-five or over, in whom the changes in the arteries are leading to a deficient supply of blood to all the organs, and in whom the arterial changes are more advanced in the heart.

(2) People in whom the arterial changes are proceeding in the heart with greater rapidity and the disease is not capable of being checked and a fatal issue speedily follows.

(3) People with damaged valves, especially aortic regurgitation.

(4) People whose hearts are embarrassed by having to labor against arterial obstruction, as in chronic disease of the kidney with high blood pressure and with damaged arteries.

(5) A small indefinite group comprising rare conditions impossible to classify.

Group 1.—People in advanced life with arterial change. The pain in these cases does not come on all at once. A man approaches his sixtieth year, accustomed to a great deal of bodily exertion which in the past he has done easily and in comfort. As time goes on there arises the time when the effort is not performed as easily as it used to be done, he is more tired at nights, or on going up hills there is a slight constriction across the chest which he ignores or tries to throw off by a spurt. Often he attributes it to indigestion. For months this may disappear, then it may recur, and at last, it may be after a long period of rather exhausting work or after some rather severe form of effort, he is seized with a pain of great severity. The attack may be of short duration or it may linger on for hours, waxing and waning in severity. If the patient and the doctor do not recognize the trouble and the patient resumes his ordinary life and exposes himself to fatigue, these attacks will tend to recur and become easier of production until a period of rest is taken. If the patient be seen by a doctor who recognizes the nature of the trouble, simple modification of the mode of life will enable him to resume his occupation, and by living at a lower level he may lead a useful life for many years with no recurrence of the attack.

Group 2.—People in whom the arterial changes proceed more rapidly. The degeneration of the arteries of the heart may proceed more rapidly than in the last group, so that death follows much more speedily after the first appearance of the pain. In the patients of this group, the history of the pain shows that it becomes easier of production and tends to increase in severity from the date of its first appearance until it culminates in a series of attacks which call attention to the gravity of the condition. In a few, a period of rest may result in a long spell of comparative freedom, but the attacks tend to recur with ever increasing ease and the heart's strength becomes so exhausted that it is incompatible with life, and the patient either dies suddenly during an attack, or a series of attacks supervene and he gradually sinks. As a rule, the signs appear earlier in life in this group than in the last, in the late forties or early fifties.

Group 3.—People with damaged heart valves. In this group the pain is associated with disease of the aortic valves. There is some peculiar relation of disease of and around the aortic valves to the nervous system and its reaction on the

heart, which has a very important bearing upon the health of the patient. We recognize the dilitation of the peripheral vessels as shown by the beating of the carotids and other superficial vessels. These cases are usually of long standing aortic regurgitation, arising from rheumatic fever or syphilis or from those senile changes which damage the aortic valves.

Group 4.—People whose hearts have to labor against arterial obstruction, such as high blood pressure from kidney disease. In this group, where there is high blood pressure usually associated with or due to Bright's Disease, attacks of angina pectoris are apt to appear during the later years of life. The condition is always well advanced and the heart's exhaustion extreme. There is always considerable enlargement of the left ventricle and the arteries are usually thick and leathery and the arterial pressure ranges from 200 to 250 mm. of mercury and over.

Group 5.—Rare conditions difficult to classify. In certain diseases of the heart, attacks of angina may appear, or in adhesive mediastinitis or other conditions whose nature may not be understood but which shows signs of gross disease. In this group are classed many cases where a diagnosis is not made. Sometimes the pain fails to appear a second time and is slight, while in other cases the pain may recur and death may occur. Even the autopsy at times fails to show cause for death or reason for pain.

B. *Toxic Angina*

Attacks of pain, sometimes of great severity and alarming in appearance, are very common among women who suffer from debility, chiefly, if not entirely, toxic in origin. These attacks are bewildering in their variety and might be broken up into a great many groups.

The sensory distrubances arising in a toxic heart may be limited to a slight aching over the left breast, with or without a small area of cutaneous pain, or there may be pain of the most agonizing description and widely spread over different parts of the body.

Many women complain of an aching in the left breast and pain on pressure, and some may consult a doctor in the fears that these are signs of a cancer in the breast. This pain and aching may be very distressing, lasting for hours, never attaining to a great severity but sufficient to cause such suffering and discomfort that their lives are rendered miserable. This happens particularly among hard-worked women with a large family or other dependents who require attention during the night so that the woman's sleep is broken and disturbed.

The pain may appear only at periodic intervals and be of an agonizing description and indistinguishable from attacks of angina due to grave disease of the heart. If the doctor takes into consideration only the attacks of pain he is liable to be misled. If, however, he recognizes that the patient is a woman under fifty and there is no gross disease of the heart, he will see the necessity for seeking for some cause of illness in other regions of the body. The most common cause for this condition is found in the intestinal tract.

While the character of an attack may resemble the attacks occurring in men with disease of the heart, the manner of onset is usually different. It may occur when the patient is at rest or on the slightest effort, while at other times the patient may undertake considerable effort with no distress. An inquiry into the previous history of the patient, particularly with reference to the state of health in which the patient had been before the attacks appeared, will afford ground for forming a safe opinion as to the gravity or absence of gravity in this kind of case.

Another feature is that the pain is frequently not limited to the well-defined area, but may spread or be described as

spreading around the whole arm and down into the abdomen. Indeed, the distribution of pain is like that of hysteria, and many of these cases are described as hysterical angina, pseudo-angina or mock angina, and in consequence the patient's complaints are treated rather lightly, particularly in view of the fact that none ever shows other signs of serious heart trouble. However, the absorption of decomposing products from the intestine has an injurious influence upon the central nervous system and to pass these serious manifestations as merely hysterical is to misinterpret their significance.

Many men who have been exposed to toxic influences (microbic infection) and have been exposed to severe bodily fatigue develop similar symptoms. Thus in many soldiers, exhaustion of the heart with pain and other sensory disturbances is not an infrequent occurrence.

Many patients who suffer from angina pectoris experience an attack when they go into the cold air. In them, there are some organic changes in the heart and the increased peripheral resistance caused by the cold embarrasses and exhausts the heart, or a constriction of the arterioles, similar to what takes place in the skin, may occur in the heart. But there are rare cases in which the cold may induce vasoconstriction and pain may occur in patients who do not suffer from gross disease of the heart, but from a toxic condition.

Summary

1. Heart pain may be produced either by disease of the heart itself or by conditions outside the heart. In either event, however, the pain is due to exhaustion of the heart muscles.

2. This exhaustion of the heart muscle is due to improper blood supply to the heart muscle.

3. The degree of pain is not indicative of the severity of the heart disease.

4. Angina in diseased hearts has a definite area of pain and is associated with a sense of constriction across the chest, sensation of suffocation and symptoms of shock.

5. The chief causes of angina in diseased hearts are: Advancing age, bacterial infection, hardening of the arteries, associated kidney diseases with high blood pressure, disease of the coronary arteries and aortic regurgitation.

6. Toxic angina is usually due to absorption from the intestinal tract, intestinal distention, worry, over-work, diseases of other organs, bacterial infection, and that the pain is more of the hysterical type.

Treatment of the heart pain consists of treatment of the cause of the heart pain, as it is but a symptom. In organic disease, removal of any source of further disease, and placing the individual in proper relationship to his work and mode of living. In toxic angina the extraneous causes should be corrected, such as intestinal disturbances, bacterial infection, nervousness due to menopause and other disturbing conditions.

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Science Notes and News

The Northwest Scientific Association has suffered an irreparable loss in the sudden demise on August 16 of Dr. J. E. Kirkwood, Head of the Department of Botany, University of Montana, Missoula, from heart failure while engaged in research at the University Biological Station at Yellow Bay, Flathead Lake, Montana. Dr. Kirkwood was a Charter Member of the Northwest Scientific Association and has been prominently identified with its activities ever since as Chairman of the Botany-Zoology Section at the Second Annual Meeting, Chairman of the Committee on "Larger Opportunities and Facilities for Research and Publication" and more recently as a Councilor.

Prof. A. M. Shaffer, Head of the Department of Chemistry at the State Normal School, Cheney, Washington, who has been on leave of absence has returned from the Sorbonne, Paris, where he has been studying for the past two years and has entered the California Institute of Technology where he will continue his work.

Prof. O. W. Freeman, of the State Normal School at Cheney, Washington, is doing graduate work at Clark University.

Recent appointments at the State College of Washington are Dr. Luther A. Black, who recently received his Doctor's degree from Iowa State College, as Instructor in Bacteriology and Associate in Dairy Bacteriology in the Agricultural Experiment Station; Fred E. Whitehead, formerly at the University of Idaho, comes after graduate study at Cornell University, as Assistant Professor in Zoology, and Mr. M. E. Sousa, from Stanford University, has been added to the staff of the Department of Geology as Instructor in Paleontology. Dr. L. E. Miles, Assistant Professor of Plant Pathology and Assistant Plant Pathologist in the Experiment Station left on September 1, for his new position as Plant Pathologist of the Mississippi Agricultural Experiment Station, and his place has been filled by the appointment of Dr. Leon K. Jones, who comes from the New York Experiment Station, Geneva, N. Y. The position of Assistant Professor of Mining and Metallurgy, in the School of Mines occupied by Hugh M. Henton, who has gone to the Alaska Agricultural College & School of Mines at Fairbanks, as Associate Professor of Metallurgy has been filled by the appointment of Guy E. Ingersoll, who has taught three years at the University of Minnesota and has had fifteen years of practical field experience.

Dr. R. L. Webster, Head of the Department of Zoology, State College of Washington, attended the 4th International Congress of Entomology at Ithaca, N. Y. on August 12-18. Delegates numbering 625 were present as the representatives of 36 different countries.

During the month preceding the opening of the Fall semester the Department of Geology of Washington State College gave its annual course in intensive field study which is a part of the regular departmental work required for graduation. The aim is to supplement the academic study with practical field work. The group selected for this course included both graduate and under-graduate students.

The work was initiated in the Swauk Valley in Kittitas County where practice in field methods of topographic mapping was followed by detailed work in the stratigraphy and structure of the Eocene and later rocks of that area. This

was supplemented by studies of the Pre-Tertiary rocks of the Blewett Pass region which furnish the basis for much of our present knowledge of the geology of the Cascade Mountains.

Subsequently, operations were transfered to the Upper Cle Elum valley where detailed studies were made of the metamorphic rocks of supposed Paleozoic age and of the Tertiary volcanics and sediments associated with them.

The final section of the course was devoted to a less detailed type of work on the physiographic, structural and economic geology of the following: Cle Elum iron, Swauk gold, Roslyn coal, Chelan copper, and Republic gold, together with the Mesozoic beds of the Tonasket area, Lake Chelan, and the Grand Coulee. The College is greatly indebted to operating companies for many courtesies which were extended freely to the party and which made the economic work exceptionally valuable.

Dr. Frederick J. Kelly, formerly Dean of Administration at the University of Minnesota and one of the foremost national authorities upon problems pertaining to the American college was inaugurated as President of the University of Idaho September 23 and 24. Dr. Kelly succeeds Dr. A. H. Upham, who resigned to become President of Miami University at Oxford, Ohio.

Prof. E. W. Ellis has been appointed Acting Dean of the School of Mines at the University of Idaho to succeed Dean F. A. Thompson, who resigned in order to accept the position of President of the Montana School of Mines at Butte, Montana.

Dr. C. L. Von Ende, Head of the Department of Chemistry at the University of Idaho, returned September first from a six months' leave of absence. Dr. Von Ende spent some time studying at the University of Wales at Aberystwyth.

Dr. J. E. Wodsedalek, Head of the Department of Zoology and Dean of the Graduate School, and Prof. C. C. Vincent, Head of the Department of Horticulture at the University of Idaho, are on leave of absence this year. Dr. Wodsedalek is at the University of Minnesota and Prof. Vincent is at Massachusetts Agricultural College at Amberst, Massachusetts.

A Forestry Experiment Station has been organized at the University of Idaho during the last year, under direction of Dean F. G. Miller of the School of Forestry. In addition to the regular staff who have been members of the teaching faculty, Dr. F. W. Haasis from the Appalachian Forest Experiment Station at Asheville, North Carolina, and Mr. G. Kempff of the Priest River Forest Experiment Station have been added. The two divisions of the Station are a Forest Research Laboratory under the direction of Dr. E. E. Hubert and an Experiment Forest in charge of Mr. Kempff.

Notice

The Fifth Annual Meeting of the Northwest Scientific Association will be held December 27-28, 1928 in the Davenport Hotel, Spokane. Members are urged to keep this date open and be ready with a paper when the Secretary issues his call.

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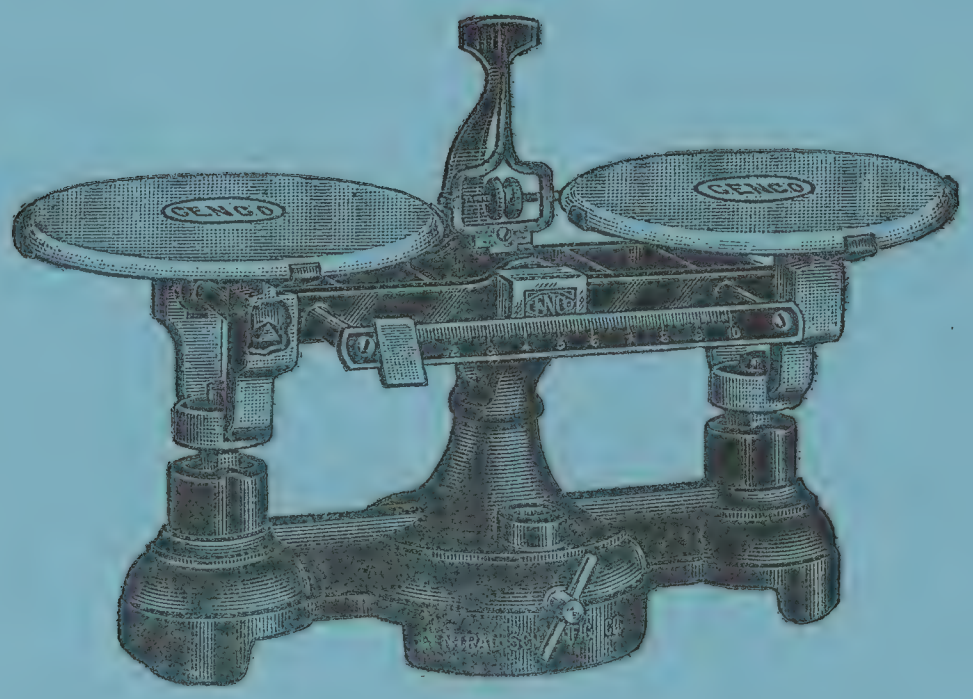

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Aims and Purposes of Collegiate Education In Agriculture

EDWARD C. JOHNSON

In an address before the Association of Land Grant Colleges in 1921, Dean Alfred Vivian of the College of Agriculture of the University of Ohio said, "What the country is today, as regards population, the city is tomorrow; in other words, our city population is made over from the country in every four generations. An analysis of the population of our cities would show that approximately 40 per cent of the people were born on farms; that about 31 per cent more are sons or daughters of farmers; that in case of the next 17 per cent, one or more of their grandparents were born on farms; and that the next 12 per cent trace back to the farm in one more generation."

While these estimates probably are high, since they would indicate that all city population traces back to the farm within about four generations, nevertheless, that they are not far from actual conditions is realized when we remember that in 1880, less than 50 years ago, 71.4 per cent of the total population was rural, whereas in 1920, less than half could be so classified. The migration from the country to the cities and the natural increase of those from country stock have been going on in the meanwhile, so that it is clear that the larger proportion of our city population today traces back to the country within comparatively few generations.

In commenting on the flow of population from the country to city in an address at the annual meeting of the International Association of Agricultural Missions, New York City, December 3, 1925, Dr. C. J. Galpin, Economist in Charge of Farm Population and Rural Life Studies of the U. S. Department of Agriculture, summarized the situation as follows:

"All careful studies of this particular situation convincingly show that up to the present, people from American farms help mightily to weave the fabric of the American city and its institutions as we know them in everyday life."

Again in a census monograph entitled "Farm Population of the United States in 1920" by Leon E. Truesdell, there is an analysis of the quality of the population that leaves the farm for the work and life of the cities and the quality of the population that remains in the country. The claim here is made that there is a considerable difference in the two groups. The former, according to Truesdell, is made up in large part of (a) those who are restless, adventurous, and hunger for excitement; (b) ambitious young men and women who feel that the cities offer the greatest opportunities, the biggest and most remunerative jobs; and (c) the great army of those who are born to be followers, not leaders, and who work best under the direction of others.

If this is correct we may well assume that the first of these is not a serious loss to the country population. Moreover, they will get farther in their work, more nearly find their place in life and be happier in the city than in the country.

The second of this group probably is comparatively small, but includes young men and women of spirit, of initiative, and of enterprise—a type of young folks that would be a great asset were they to remain in the country. This is a serious drain. Whenever such folks leave, potential leaders are lost.

The third undoubtedly includes the great army who work best and accomplish most under the direction of others. They are willing workers who need supervision, and the initiative and enterprise of others in order that they may accomplish most.

It would seem, therefore, that a very large proportion of those who leave the country for city occupations belong to the extremes of population namely: the restless and adventurous, some with exceptional ambition and enterprise, and a large number who are content to follow rather than to lead. This conclusion also is arrived at by Zimmerman, Duncan, and Frey, of the University of Minnesota on the basis of a study of 694 Minnesota farmers, published in the American Journal of Sociology, Volume 33, No. 2., September, 1927, in a paper entitled "The Migration to Towns and Cities," III. They say, "Cities acquire the extremes. The unskilled laborer who produces best under the supervision of others is better off in the cities. Clerical laborers, or the "white collars" find no place in agriculture. They prefer social position at any price. On the other hand, the professionals find their opportunities in the city. The law of net rural-urban selection may be stated as follows: *The cities attract the extremes, while the farms attract the mean strata in society.* Who shall say that one combination is better than the other?"

Now then what is left to make up the rural population? Included in this first of all is a group of individuals of marked ability, of large capacity, of exceptional initiative, who love the land and farm life, and who, while they realize that undoubtedly they too would succeed were they to elect the life of the city, nevertheless love the country and have such a vision of farm life, what it means, and what it may become under the conditions of today and of tomorrow, that they choose to cast their lot "in the large open spaces." Here they see their greatest opportunity. Here they feel they may exercise their energies to the utmost. Here they will use the brains with which they are endowed, and the training which they achieve. Here they will win personal success, and build their homes, and here they will lead and will receive the appreciation of their fellows.

But the largest group remaining in the country after all, is that considerable proportion who constitute the mean between the extremes, who belong to our work-a-day world, who are interested in remaining in the occupation to which they were born, who are intelligent, steady, able workers, moving forward in beaten paths, who love the country and their homes. These are the backbone of the American farm family, and they make up their part of that large multitude of Americans which may be classified as the "average man." Without them neither the country nor the city could endure.

But what has all this to do with the aims and purposes of collegiate education in agriculture? The answer, I think, is clear to all of us. Because of the continued flow of populations from country to city and the considerable proportion of the population which always will live in the country, the quality of the country population is extremely important. That cannot be assured unless included in it is a leaven of men and women, especially well educated and trained for life in the country, men and women who raise the average of intelligence in their community, men and women who are able to assist in so shaping the farm occupations, agricultural conditions, and the life and thought of farm communities that not only those who leave to become a part of the rushing stream in our cities, but those who remain in the more quiet flow of country life will attain the highest possible standards in intelligence, in capacity to accomplish, in morality, and in culture. In this group of trained persons should be

found, first of all, that fine nucleus of ambitious, energetic and able young men and women who are distinctly rural minded and appreciate that their greatest success and service will be realized in connection with country life, and as many as possible of that large middle group who will use the fine training they receive in connection with their own farm business, their own home, and their own community. One great aim and purpose, therefore, of agricultural education, is to train men and women for the highest type of rural citizenship, and for the occupations of the farm and the farm community. Certainly the farm-minded young man of ability, initiative and energy can exercise his full powers only if he is trained for the work he is to do and for the position in the community he is destined to hold.

Another purpose and aim of collegiate education in agriculture is to train young men and women for the important field of leadership in research and in teaching in colleges and universities, in secondary schools, and in agricultural extension. No one questions that here is a large field of leadership on the proper functioning of which the progress of agriculture and of farm life in large measure depends. This field today is absorbing a very considerable part of the graduates in agriculture from our Land Grant Colleges. Into it is attracted a number of those who prefer the towns and cities as a home, but still are rural minded. Into it also come many who look to the country and its activities as their permanent place of work. According to the latest available figures, namely, up to June 30, 1927, there were 5,055 extension workers in the United States of whom 3,719 were in the service of agriculture and agricultural groups. Then there are some 3276 Smith-Hughes schools in which there are full time agricultural teachers, and some 200 teacher trainers and directors in addition. On the Staffs of our Experiment Stations, there were 2852 workers in the spring of 1927. There is a large group of men in the U. S. Department of Agriculture in research work and in addition in this Department and in the State Departments of Agriculture a large number who have charge of the enforcement of agricultural laws. Certainly the aim and purpose of collegiate education in agriculture, therefore, should be in part to train men for these positions of leadership and responsibility in the field of public Agricultural Service.

A third aim and purpose of collegiate agricultural education is to train young men and women for that ever expanding field known as agricultural business, a field closely related to agriculture and of large influence on agricultural progress. Included in this field are such business enterprises as marketing farm products, the feed and seed business, the farm implement business, work with farmers' organizations, the rural credit business, banking in rural communities, and agricultural journalism. In all these and many others, that broad, scientific training, with agriculture as a background, secured in our colleges of agriculture apparently contributes greatly to individual success and ability to serve.

That this field is growing rapidly is well illustrated by the field of rural electric service, which is now undergoing large expansion. The large power companies themselves stress the point that the educational qualifications for this field should be in the realm of agriculture rather than in the realm of electricity. Some of them already are selecting agriculturally trained men for important positions. The General Manager of one of the large power companies of the Northwest, for instance, is a graduate in agriculture from one of our leading institutions, and already several rural electric service men are agricultural graduates.

Indeed, within the last month both the Colleges of Agriculture of the State College of Washington and the Oregon Agricultural College have been requested

by Northwest Power companies to organize agricultural short courses or schools for rural electric service men to meet in part this need for education in agriculture.

Fourth, the aim and purpose of collegiate education in agriculture is to give a broad, scientific training based on the natural sciences, on applied agricultural sciences, on economics, english, languages and the arts, an education which will be worth while in any sphere of endeavor in which those receiving it will find themselves.

These being the purposes and aims, let us see for a moment if the occupations followed by agricultural graduates may not give us a fair estimate of whether or not they are realized. Happily, a number of studies of the occupations followed by agricultural graduates have been made. The most recent of these is by Dr. E. H. Shinn, Specialist in Agricultural Education of the U. S. Department of Agriculture, and was reported to the meeting of the Association of Land Grant Colleges and Universities in Chicago in November of last year. He tabulated and summarized the reports of occupations of alumni for some 19 of our agricultural colleges as reported to him by the Deans or other responsible officers of those institutions, and found that on the average 27.8% of agricultural graduates enter the farming occupation; 24% teaching; 8.4% extension work; 5.8% research; 10.4% business closely related to agriculture; and 23.6% miscellaneous occupations. In certain institutions the proportion going into different occupations varied considerably from the average. Of the agricultural graduates from the State College of Washington, for instance, who reported on their work, 31% were farming; 26% were teaching; 5% were in extension work; 5% in research and experimentation; 13% in business related to agriculture; and 20% in miscellaneous enterprises. In other words, approximately 80% of the total today are engaged in the occupations preparation for which is one of the leading aims of a college of agriculture. Were it possible to get complete statistical data on the graduates and those who have not graduated, but who have taken collegiate work in agriculture for one, two, or three years and then have dropped out, I am confident that upwards of 40% or more are farming; 20% to 30% more are in positions of leadership in agricultural research, teaching and extension, and 10 to 15 per cent more in business enterprises closely related to agriculture.

In other words, 80% to 90% are in the agricultural field. That the greater number of all of them are better citizens, doing more constructive work, exercising larger leadership and appreciating life more because of the broad, scientific training they have been privileged to enjoy, cannot be doubted.

The results of Agricultural Education, therefore, would seem to justify the statement that in so far as students have come to our colleges of agriculture and have there completed their work, the aims and purposes of this type of modern education have been realized in its graduates. When these aims and purposes are known and appreciated more generally, and results understood more fully than they are today, I have no doubt that more and more of our young people seeking college education will be attracted to the agricultural field and that the result will be of net advantage to the population both of city and of country.

Office of the Dean,
College of Agriculture,
State College of Washington,
Pullman, Washington.

Structure of the East Side of the Cascade Mountains

EDWIN T. HODGE

New and specific facts have been found which solve in part the problem as to the origin of the Cascade Mountains as found in Oregon and explain the different history which they record in comparison with the Siskiyou Mountains in Southern Oregon and the "Cascade Mountains" in neighboring states. The field work of the writer for over ten years has been spent in the Cascade Mountains of Alaska, British Columbia Washington and Oregon and during this time he has been impressed with the fact that students of the Cascades elsewhere have assumed that these mountains in Oregon display identical features and history. Another popular belief erroneously based upon the descriptions of early geologists, is that eastern Oregon is a great Columbia River Basalt Plateau. The main facts only will be presented in this brief paper; the large mass of material in support of the new conclusions will be offered later in a report now in preparation.

The Columbia River Basalt Formation does not cover all, nor a large part of eastern Oregon and does not lie on a true plateau. It is to be doubted if it covers even fifty per cent of that area. Where it does form the main cover it is folded, warped and faulted. Its absence fortunately, exposes in part the basal structures of eastern Oregon.

One of these main structures has been recognized, and is here briefly described. Thus in Crook, the southern part of Malheur and northern part of Harney counties very old rocks are exposed at the surface. Rocks of about Jurassic age have been known in the vicinity of Burns for a long time. During the last two summers, Dr. E. L. Packard has examined a large Palaeozoic section near Suplee. The uplift which has exposed these rocks has been traced northwest by the writer into the Cascade Mountains.

A new area of Cretaceous rocks was found near Grizzly. Surrounding this and the older Palaeozoics and Jurassic rocks is an enormous area of the Clarno Formation (Eocene). These Clarno rocks have been recognized and mapped for the first time in their extensions northwestward from the upper John Day River Basin and the upper Crooked River Basin. They have been traced to the Deschutes River where in its profound canyon a beautiful and thick section extends from Kaskela for over twelve miles to Frieda. To the northwest they form the main mass of the Mutton Mountains and extend directly into the eastern flank of the Cascade Mountains near Mount Wilson.

Lying on the flanks of this north west—southeast area of old rocks were found the whole geologic sections which have been described so thoroughly by the workers on the upper John Day River Basin. The John Day and Columbia River Basalt Formations on both sides of this old range of mountains were traced with unbroken continuity into the Cascade Mountains. As a by-product of this structural study several important discoveries may be parenthetically mentioned.

(1) The new area of Cretaceous proves that the Cretaceous embayment did not reach into Oregon by a long narrow arm from the southwest. This venerable theory must be replaced by a conception of a broad

transgression directly from the west and united, perhaps, with Washington and British Columbia.

(2) A large new area of John Day was found exposed in the Deschutes River from Vanora north ward to Nena and in its immediate tributaries. The vertebrate fossils found give promise that the finds in the new area may surpass those of the famous John Day collecting grounds.

(3) Several of the Basalt formations are much younger than the Columbia River Basalt Formation. The Columbia River Basalt of Eastern Oregon has, at last, been traced continuously to the Columbia River where it is found to be equivalent to one, but not all of the basalt formations exposed there.

The John Day and younger formations lie on the Clarno and old formations with a great unconformity. These older rocks were folded, in places up to high angles and eroded to a state of maturity before the younger rocks were deposited upon them. In other words in the pre-John Day Formation-time a great range of mountains extended across central Oregon from near Burns northwestward. The axis of this range may be marked by the post offices of Burns, Suplee, Ashwood and North Junction. Is it only a coincidence that the strike of this range, as traced to the foot of the Cascade Mountains and projected, extends so as to pass under Mount Hood and lie almost parallel with the big bend of the Columbia River from Portland to Longview? Or, is it only a coincidence, that the strike of the old range is parallel to the main Pacific Coast lineaments of North America?

Folding along this axis has taken place since the deposition of the Columbia River Basalt Formation. To some extent, however, the younger folds appear to be due to movements along new directions acting against this old range as a fixed buttress. The name Ashwood Mountains is here proposed for this old range of mountains.

The Ashwood Mountains may be geologically related to the Siskiyou and Cascade Mountains in Northern Washington and British Columbia. The Ashwood Mountains differ from and underlie the Cascade Mountains as hitherto defined and described in southern Washington and Oregon. In the area studied, at least, these older mountains pass beneath a younger range which trends north and south. This younger part of the Cascade Mountains contains the John Day Formation or its time equivalent and the Columbia River Basalt Formation. These formations were supplied in part from sources outside of this younger range, yet their main source was from volcanoes aligned along the axis of the new Cascade Mountains. These volcanoes and their reworked materials produced a series of deposits including the John Day and Columbia River Basalt formations, which have been laid one on top of the other until they formed a thick layer of materials covering all of the Cascade Mountains and much of eastern and western Oregon. The Cascade Mountains stand above the rest of Oregon because they were the source of these and later volcanic deposits and because within the body of this north-south range are found the thickest sections of these volcanic formations. These later deposits form a simple pile of volcanic materials which conceal the older formations and form the observable portion of the Oregon Cascade Mountains. These later deposits have been slightly folded and fractured and appear to have a slight eastward dip as if part of a fault block with a badly eroded fault scarp fronting the Pacific ocean.

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Species of Ascochyta Found on Legumes in the Northwest

RODERICK SPRAGUE

These notes are taken from research work for the doctorate which will later be published in full.

It was shown by Linford and Sprague (1) and later by Jones (2) that there were three distinct forms of Ascochyta on the pea (*Pisum sativum L.*) and that the sphaeropsidaceous species *Ascochyta pisi* Lib. was not related to *Mycosphaerella pinodes* (Berk. and Blox.) Stone which had a conidial stage of its own. In addition a small-spored form which Jones calls *Ascochyta pinodella* was found to be common. Since no ascigerous stage is found with *A. pinodella* through months of experimenting the writer feels that Jones' name is valid.

With the whole field thrown into uncertainty by this recent work the writer has attempted thru extensive inoculations, examination of most of the Exsiccati in this country and of some foreign countries, and by a study of many cultures on standard and special media to place all the leguminous forms of Ascochytae in their proper niche. The following notes pertain to the northwest only:

On Peas

(*Pisum sativum* and varieties.)

1. *Ascochyta pisi,* common on aerial parts, forming light-buff to whitish spots with definite reddish to brown borders. Pycnidia golden, spores clear, cylindrical, usually less than 13.5 microns mean spore length. The findings of Jones (2) along this line are not typical.

2. The conidial stage of *Mycosphaerella pinodes* (ascigerous on dead plants) causes indefinite brown, usually zonate spots on aerial parts and a dark footrot in addition. Spores are not so cylindrical as above and are usually over 13.5 microns mean spore length. Not uncommon.

3. *Ascochyta pinodella,* symptoms as in the last mentioned form. Spores much smaller, many non-septate, 8-12 microns mean spore length. Common in Montana (collections by Dr. M. B. Linford).

On Vicia spp.

A. pisi, a form on *Vicia villosa,* develops similar symptoms to *A. pisi* on peas. Inoculations of many economic legumes shows the form to be physiologically distinct from the pea organism in that it is able to cause leaf spotting on vetches readily but only slightly on the pea. The spores of the vetch *A. pisi* usually run considerably above those of the pea organism but this character is not very reliable. Such collections as the one made by Kienholz at Pullman, Wash., are very close to *A. pisi* in all morphological characters. On agar all Ascochyta isolations from this vetch from scattered parts of the country were identical.

A. pisi, a form on *Vicia faba* from Corvallis, Ore. collected by F. R. Jones, produces large leaf spots which due to the host reaction have dark-brown to dirty borders with lighter centers. The pycnidia are large and of a "pseudo-pycnidial" nature, a term in which the writer can see little value. The spores are comparatively large being around 20-26 microns mean spore size, but somewhat variable. However on potato-1 per cent dextrose agar the fungus is identical in most ways to *A. pisi* on peas and when this form is inoculated onto other Vicia species that do not have the tendency to blacken

on injury the symptoms are very similar to *A. pisi* on *V. villosa.* The writer feels that *A. fabae* Speg. is synonomous. (4)

On Alfalfa

(*Medicago sativa.*)

Ascochyta imperfecta Pk. causes a very common, unimportant leaf spot thruout all of the northwest. It has been found by study of inoculation data and cultural work that *A. imperfecta* while variable, is the only species on alfalfa in this country.

Material collected by Vernon Simmons at Spokane and in Wyoming and labelled *A. pisi* var. *medicaginis* by Saccardo (3) the writer hesitatingly calls *A. imperfecta.* The superficial, brown-bordered stem lesions with prominent pycnidia are very unusual.

A number of other forms may be expected in the northwest. *A. lathyri* on Lathyrus spp, *A. medicaginis* on *M. lupulina, A. meliloti* on Melilotus spp. and *A. phaseolorum* and *A. boltshauseri* both on Phaseolus spp., all might be encountered.

The writer would be pleased to receive collections or isolations of any leguminous Ascochytae at any time.

Dept. of Botany,
Univ. of Cincinnati,
Cincinnati, Ohio.

Literature Cited

1. Linford, M. B. and Roderick Sprague. Species of Ascochyta parasitic on the pea. Phytopath. 17:381-397. 1927.
2. Jones, Leon K. Studies of the nature and control of blight, leaf and pod spot, and footrot of peas caused by species of Ascochyta. N. Y. Agr. Exp. Sta. (Geneva) Bul. 547. 1927.
3. Saccardo, P. A. Mycetes Boreali-Americani (J. R. Wier-Spokane, Wn.) 1919. Nuav. Giorn. Bot. Ital. 27:82. 1920.
4. Spegazzini, C. Annales del Museo Nacional de Buenos Aires. Sec. ser. 6:321-322. 1899.

Science Notes and News

Dr. E. T. Bodenberg, of the University of Washington, who has done graduate work at that institution and also at the Ohio State University, has recently been appointed Instructor in Biology at Whitman College, Walla Walla, Washington.

Dr. G. G. Hedgcock, of the Office of Forest Pathology of the U. S. Department of Agriculture, Washington, D. C., spent last summer in the region of Northport, Washington, making a special study smelter injury resulting from the smelter at Trail, B. C. He will return next season to continue the investigations.

Dr. J. S. Cooley, of the Office of Fruit Disease Investigations, U. S. Department of Agriculture, Washington, D. C., has been spending the past season in the Hood River District, making a thorough study of the perennial canker of the apple, a disease which has been causing heavy losses. A special Federal appropriation of $15,000 has provided for this investigation.

Notes on the Geology of Chewelah Quadrangle, Stevens County, Washington

R. H. B. JONES

Introduction

Chewelah Quadrangle, named after the town of Chewelah, is a 30 minute quadrangle situated approximately 50 miles north of Spokane.

The following notes are based on field work carried on in the northern half of the quadrangle during the summer of 1927. The writer was ably assisted in this work by Mr. Virgil E. Barnes, graduate student from the State College of Washington.

General Statement

Previous work in this general region is summarized in Bulletin No. 20 of the Washington Geological Survey and will not be repeated here. This bulletin consists of a report on the Mineral Resources of Stevens County, and is essentially a reconnaissance report in which the geology is broadly generalized. The field work for its preparation was insufficient to permit unravelling the geology, or even to determine accurately geologic boundaries.

The object of last summer's work in the Chewelah Quadrangle was to make a definite start on the stratigraphic column, to determine the controlling structure, and, if possible, to obtain fossil evidence for the age determination of the rocks

Before outlining the information resulting from last summer's work a general statement of previous work will be quoted (1).

"The rocks of Stevens County for purpose of description may be divided into five main groups. They consist of a very thick series of apparently conformable metamorphosed sedimentary rocks whose geologic age can not be definitely determined because of total lack of fossil evidence. There are very large areas of batholithic igneous rocks of acidic and intermediate composition. A third consists of a thick series of lavas, tuffs and interbedded sediments of Mesozoic and Tertiary ages. The fourth division is composed of acidic and basic intrusive dikes of probable Tertiary age. The fifth group consists of horizontally-bedded Quaternary deposits of poorly consolidated sands, gravels, clays and silts of glacial and fluviatile origin. All of these have been subdivided into 38 separate units for purpose of description and mapping. The boundaries of these units as represented upon the areal geological map accompanying this report are in many places very indefinite. The data upon which the contacts have been arbitrarily drawn are open to varying interpretations and future field studies may result in modifications not only in the locations of the contacts but also in the grouping of the several divisions of the metamorphic series."

Sedimentary Rocks

"Approximately three-fifths of the area of Stevens County is composed of metamorphosed sedimentary rocks. These have been invaded and in many places greatly disturbed by batholithic masses of granite, syenite and granodiorite. The metamorphosed sedimentary rocks consist of quartzite, argillite, calcareous argillite, slate, limestone, dolomitic limestone, and schist. These types often show great variations within themselves and they

1. Weaver, C. E. The mineral resources of Stevens County. Wash. Geol. Survey Bul. **20**:44-45. 1920.

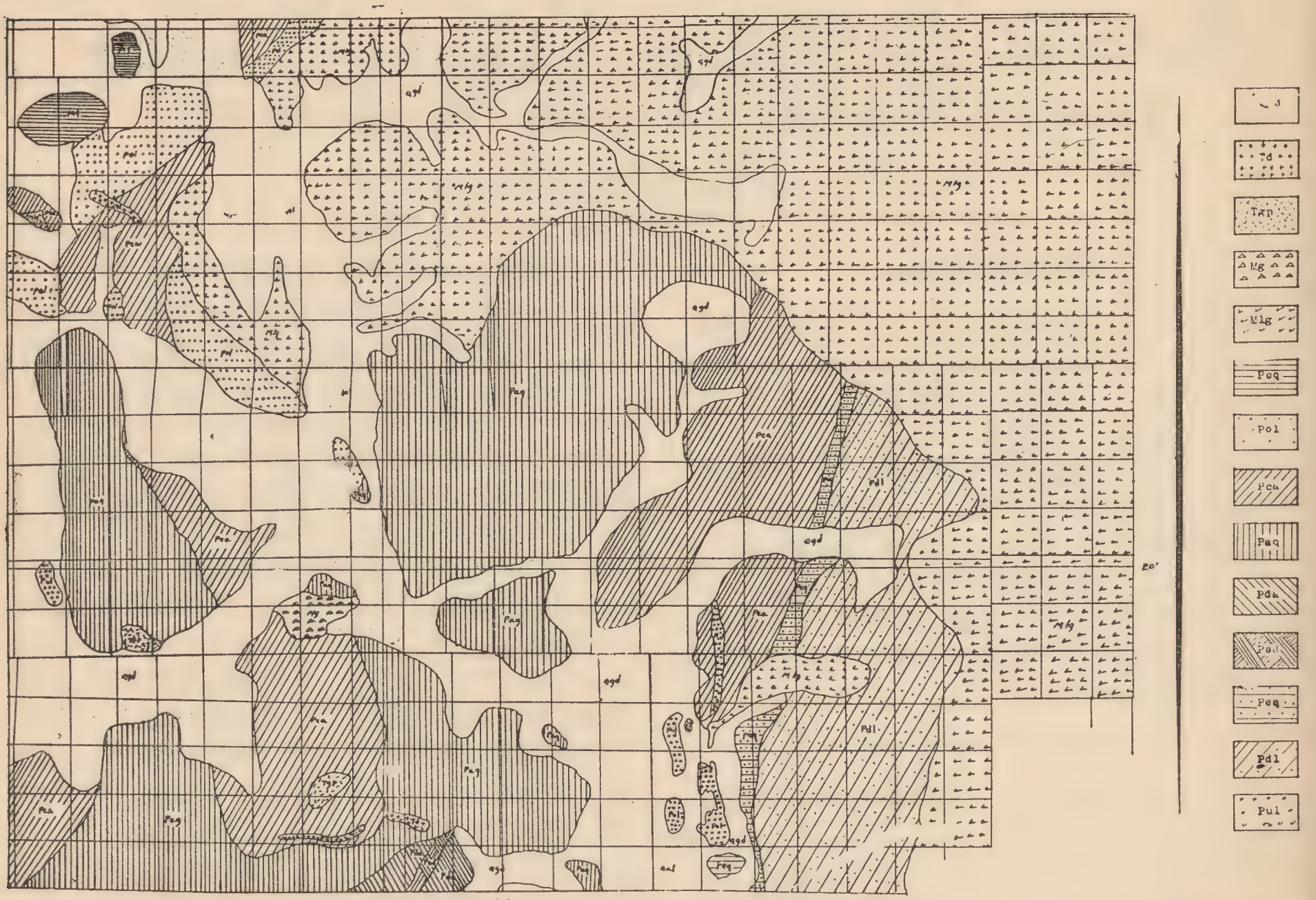

Fig. 1. North half of Chewelah Quadrangle. After Weaver. See p. 115 for explanation of Legend.

occur as rock outcrops in those areas of both low and high relief although they are more common in the rugged mountainous districts. This is largely due to the fact that they have resisted erosional agencies much more efficiently than the granite masses. Large areas of the county are heavily covered with thick deposits of glacial drift and deep layers of soil so that wide stretches of the metamorphic rocks are concealed. Throughout the larger part of the county the metamorphic sedimentary rocks have a prevailing strike which ranges from a northerly to a northeasterly direction. The usual dip is persistently to the west and northwest and averages greater than 45°. The lithologic differences in the several units of this metamorphic series are usually not sufficient to render their distinction easy over wide distances. No fossils of either animals or plants have been collected from any of the metamorphic rocks within the county although fragments of such have been reported from a single locality. Neither erosional nor angular unconformities have been definitely determined at any place within the county. The total absence of fossils, unconformities, and lithologic characteristics of a definite nature anywhere within this thick series of metamorphosed sediments renders its separation into formations of definite geologic age almost impossible."

Several points in this statement are of special interest: (1) In some cases the geologic boundaries are arbitrarily drawn; (2) large areas of the country are heavily covered with glacial drift; (3) the lithologic differences in the several units of this metmorphic series are usually insufficient to render their distinction over wide distances; (4) no fossils of either animals or plants have been collected from any of the metamorphic rocks within the county; and (5)

the several units are subdivided into 38 separate units for purposes of description and mapping.

The thickness of the series from such a grouping totals in the neighborhood of 100,000 feet or 20 miles; more than three times the height of Mt. Everest.

Structure

Several interpretations for the structure of this area have been advanced. These are: (1) "The rocks may be involved in an extensive monoclinal fold in which the entire series of strata are dipping to the west; (2) the several stratigraphic units many represent a repetition of the same beds due to strike faulting, or (3) all of the stratigraphic members of the series may be involved in a number of overturned and pitching anticlinal and synclinal folds."

In the first case, the enormous thickness of over 20 miles which would have to be assumed on the basis of a great monoclinal fold would render this explanation most improbable.

In the third case, detailed work shows that all the beds do not dip to the west. A normal anticline occurs to the southeast of Chewelah. Folding does cut down to a considerable extent the apparent great thickness on the generalized reconnaissance map. (Fig. 1) Close folding could hardly be expected in a quartzite formation several thousand feet in thickness. It has not been observed here, although the argillite series underlying the quartzite is in some cases closely and complicately folded. The quartzite tends to form parallel folds while the argillite often produces similar folds.

Where the beds dip westward, evidence such as, bedding and cleavage relations, gradation in grain, ripple marks and cross bedding show that, in all cases determined, they are not overturned. The top of each bed is right side up.

The second suggestion, that of strike-faulting is essentially correct. A number of major overthrust faults have been located. These overthrusts are from the west. Rocks from the westward have moved along fault planes upward and to the east. To illustrate, the evidence for one of these faults may be presented.

Three miles northwest from Addy, in T 33, R 349 E, Sec. 3 and to the northwestward, the series consists of massive to well bedded, hard, crystalline, light pinkish quartzite. Near the top of this quartzite there occurs a characteristic marker horizon several feet in thickness consisting of an arenaceous quartzite containing worm holes normal to bedding. This grades into a limestone which in turn gives away to argillite. This argillite is in part carbonaceous and some bands are jet black in color. The structural relations between bedding and cleavage indicate that here the controlling structure is the eastern limb of a syncline. This structure is constant for several miles to the northwest. (Fig. 2)

The west limb of this syncline should outcrop to the west. The beds should dip eastward on Dunn Mt. forming the western limb of the same syncline; furthermore, the beds should occur in a reversed sequence because of the reversal of dip. They do not. The beds on Dunn Mt. dip westward. Cleavage and bedding indicate the controlling structure to be the west limb of an anticline with the beds dipping westward. A careful study of the section shows the series to be similar to the east limb of the syncline several miles to the east. The eastern side of Dunn Mt. consists largely of quartzite. Near the top of this formation is an arenaceous quartzite containing worm holes like those in T 33, R 39 E, Sec. 3. Overlying this quartzite is a limestone similar to the limestone near Marble Valley school. It gives way to an argillite which is partly carbonaceous and black.

In summary, the evidence presented thusfar shows: first, that the normal structural relations resulting from folding do not occur, and second, that beds

of a similar lithologic character are repeated.

One improbable interpretation is that there was a similar repetition of conditions of sedimentation laying down two distinct series similar in detail on top of each other. The geologic map accompaning Bulletin No. 20 has these two possible series mapped as the same. But to the north of Dunn Mountain the same limestone (Old Dominion Limestone) is mapped both to the east and west of argillite (Pca-Chewelah Argillite). The interpretation of the structure from the map is an anticlinal structure because younger beds outcrop on either side of an older one. No such anticline exists.

A second explanation is that the same beds are repeated due to faulting. This explanation is satisfactory as far as the discrepancy in structure is concerned. Is this fault a strike fault? If so, the fault plane should be parallel to bedding, this is not the case. The fault truncates the quartzite along the eastern side of Dunn Mountain. It truncates the quartzite in such a manner as to eliminate it to the north and to bring the limestone in fault contact with the overlying argillite. Due to faulting, the stratigraphically underlying limestone now rests on top of the argillite. Tracing the fault plane fur-

Figure 2

Preliminary Geological Map - North Half of Chewelah Quadrangle

ther to the north it truncates back through the limestone exposing quartzite again along the north edge of the quadrangle.

This structure may be interpreted as a major overthrust fault, beds from the west being thrust up and over the beds to the east. The fault is not strictly a strike as it truncates several thousand feet of quartzite.

The evidence submitted above is threefold: (1) The normal structural relations which would result from folding alone do not occur; (2) beds of similar lithologic character, even to detail such as the wormhole quartzite are repeated in the same sequence; and (3) beds, along their strike, are truncated in such a manner that faulting alone satisfies field relations.

Additional evidence might be cited such as a well-marked fault with a throw of 700 feet and a heave of approximately 3000 feet on the east side of Dunn Mountain; also brecciation and shearing of quartzite and marked discontinuity of separate blocks. Such details will be presented in the final report on this area. Some can be recognized on the geological map (Fig. 2).

Stratigraphy

The geologic section for Chewelah Quadrangle (grouping quaternary and glacial deposits) taken from Bulletin No. 20 is:

Drift	Qgd.
Diabase	Td.
Granite Porphyry	Tgp.
Greenstone	Mg.
Loon Lake Granite	Mlg.
Colville Quartzite	Pcq.
Old Dominion Limestone	Pol.
Chewelah Argillite	Pca.
Addy Quartzite	Paq.
Deer Trail Argillite	Pda.
Stensgar Dolomite	Psd.
Eagle Mtn. Quartzite	Peq.
Deer Lake Argillite	Pdl.
Undifferentiated Limestone	Pul.

The section for Figure 2 is:

Loon Lake Granite	Mgl.
Greenstone	Mg.
Chewelah Argillite	Pca.
Old Dominion Limestone	Pol.
Addy Quartzite	Paq.
Undifferentiated Limestone	Pul.

Figures 1 and 2 show the distribution of these formations.

Portions of Figure 2 are left blank. These blank areas represent quaternary and glacial deposits, areas where the detailed geology would be confusing and areas where information is lacking.

Because of overthrust faulting the same formation has previously been separated and separately described. In such cases the lithologic descriptions are strikingly similar.

At present the correlation across the Colville valley at Chewelah is not satisfactory and it will not be discussed further.

Figure 1 shows Iron Mountains composed essentially of Addy Quartzite (Paq). Such is not the case. South of Addy a greenstone series outcrops. The same series occurs across the Colville valley to the west southwest.

This volcanic series has fairly good graduation into argillite. Its different members include flows, in part amygdaloidal and sheared; breccias, probably tuffaceous phases as well as semiconglomeratic portions. The latter contains limestone and argillaceous fragments varying in size from minute particles to fragments exceeding ten feet in length. This series is being discussed by Mr. Bennett and will not be dealt with in this article.

Previous reports have emphasized difficulties of correlation because of the complete lack of fossils in this region. The credit for locating the first fossils in this area belongs to Mr. Barnes. Two fossil localities have been uncovered: One in

T 33 N R 40 E, Sec. 22 the other in T 33 N R 38 E, Sec. 14. The former contains brachiopods and pelecepods, not yet definitely identified but possibly of lower Paleozoic age; the latter locality contains both bivalves and trilobites. The importance of the location of fossils is obvious. The series can be identified. It is definitely removed from the Pre-Cambrian. Now that the series is proved to be fossiliferous undoubtedly more diligent search will reveal other fossil localities which should give more accurate knowledge of the age of these rocks and should aid in their correlation. It is therefore with great pleasure that I acknowledge my indebtedness to Mr. Barnes for his diligent and tireless work which resulted in the uncovering of two fossiliferous localities in such an apparently barren and hopeless field.

In final summary it may be pointed out once more that last summer's work has demonstrated that working primarily from structural interpretation, the geology of this area is capable of solution. Glacial drift, elusive and complicated structures make such work slow, for it is unsafe to project contacts or structures for any distance. They are usually eliminated, truncated or repeated by faulting.

The location of fossils provides an excellent tool for the unravelling of the stratigraphic puzzle.

Overthrust faulting, the controlling factor in this area is not unusual in other parts of the world. Classical examples include the Lewis and Livingstone ranges of the Rockies where Pre-Cambrian beds have been overthrust, also to the east for distances ranging from 17 to 25 miles. Other examples occur in the Northwest Highlands of Scotland and in the Alps.

Department of Conservation and Development,
Division of Geology,
Pullman, Wash.

PROGRAM
OF THE
Northwest Scientific Association
December 27 and 28
1928
DAVENPORT HOTEL
SPOKANE, WASHINGTON

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REDUCED RATES FOR MEETING

A convention certificate will be sent with the December issue of Northwest Science to all members from outside the city of Spokane. This certificate, if presented to railroad agents at starting point, will entitle members to a round trip fare of one and one half times the regular one way fare. Exception: this arrangement does not apply in Montana.

NEW MEMBERS

Membership is open to any one paying the annual dues of one dollar. Members receive without additional cost the issues of Northwest Science, the official publication of the Association.

HEADQUARTERS

The Davenport Hotel will be the headquarters of the Association and all meetings will be held in the hotel rooms.

REGISTRATION

The Registration desk will be found on the Mezzanine Floor of the Davenport Hotel. All old members should register and receive their official badge for the meeting. At the same time they should see that their dues are paid for 1928. Payment also of dues for 1929 will facilitate the work of the Secretary-Treasurer. New members should fill out an application card and pay the annual dues. Visitors are requested to register and secure a visitor's badge.

Registration will begin at 9:00 a. m. December 27 and continue until noon the next day. All are urged to register as early as possible.

ANNUAL DINNER

Breakfasts — Luncheons

The annual dinner will be held at 6:30 p. m. Thursday in the Elizabethan Rooms. Tickets should be purchased at the time of registration. Price, $1.50. Members and friends are invited to attend.

Luncheons of the Association will be held on both Thursday and Friday, December 27 and 28. Price sixty-five cents. On Thursday the luncheon will be held in the southwest corner of the Mezzanine Floor. Major John D. Guthrie, Assistant Forest Supervisor, Portland, Oregon, will speak. Subject: "The National Forests—Their Part in State Development."

On Friday the luncheon will be held in the Marie Antoinette Room. Francis A. Thomson, President of the State School of Mines, Butte, Montana will speak. Subject: The Gold Production of the Early Placers of the Northwest.

There will be a Sigma Xi breakfast for members and friends on Friday morning at 8:00 o'clock in the East Banquet Hall. Reservations may be made at the registration desk until Thursday evening. Price seventy-five cents.

A Phi Delta Kappa breakfast for members and guests will be held on Friday morning at 8:00 o'clock in Room 200. Reservations may be made at the registration desk until Thursday evening. Price seventy-five cents.

CONDENSED SCHEDULE OF ALL MEETINGS

Thursday, December 27

9:00 A. M.—Registration: Mezzanine floor
10:30 A. M.—General Session. Elizabethan Rooms A, B, C.

12:00 Noon—Luncheon. Southwest Corner Mezzanine Floor.

2:00 P. M.—Botany—Zoology. Elizabethan B, C.
Chemisty—Physics. Elizabethan, D, E.
Education. Room 200.
Engineering. Elizabethan A.
Forestry. East Banquet Hall.
Geology—Geography. Mandarin Room.
Plant Pathology. Tent A.
Social Science. Hall of the Doges.

3:30 P. M.—General Session. Medical Program. Elizabethan A, B, C.

6:30 P. M.—Annual Dinner. Elizabethan Rooms.

Friday, December 28

9:00 A. M.—General Session. Business Meeting. Elizabethan A, B, C.

10:30 A. M.—Botany—Zoology, Tent C.
Chemistry—Physics. Tent A.
Education. Tent B.

12:00 Noon—Luncheon. Marie Antoinette Room.

2:00 P. M.—Botany—Zoology. Elizabethan B, C.
Chemistry—Physics. Elizabethan D, E.
Education. Room 200.
Forestry. Mandarin Room.
Geology—Geography. East Banquet Hall.
Plant Pathology. Tent A.
Social Science. Elizabethan A.

GENERAL SESSIONS

Thursday, December 27

10:30 A. M.—General Session, Elizabethan Rooms A, B, C. President E. A. Bryan presiding. Address: The Effect of Changed Environment on a Pure Line of Plants—Alfred Atkinson, President Montana State College, Bozeman, Montana.

12:00 Noon—Luncheon, Southwest corner Mezzanine Floor. Address: The National Forests—Their Part in State Development—Major John D. Guthrie, Assistant District Forester, Portland, Oregon.

3:30 P. M.—**General Session. Medical Section.**
Elizabethan Rooms A, B and C.
Dr. George A. Downs, Spokane, Washington, Chairman.

1. Election of Officers.
2. Clinical Use of the Electrocardiograph—Dr. George H. Anderson, Spokane, Washington.
3. Overweight in Relation to Life Expectancy—Dr. Charles Doland, Spokane, Washington.
4. Scientific Fundamentals in the Mending of the Maimed—Dr. Mitchell Langworthy, Spokane, Washington.
5. The Common Cold—Dr. Fred Sprowl, Spokane, Washington.
6. Health is Wealth—Dr. S. E. Lambert, Spokane, Washington.
7. Venereal Diseases From a Social Standpoint—Dr. William Pennock, Spokane, Washington

6:30 P. M.—**Annual Dinner.**
Elizabethan Rooms
President E. A. Bryan, Chairman.
Address of Retiring President, L. K. Armstrong, Spokane, Washington.
Subject: The Northwest Scientific Association; a Vision of the Future.

Friday, December 28

9:00 A. M.—**General Session.**
Elizabethan Rooms A, B, C.
President E. A. Bryan, Chairman.
Business Meeting. Reports of Officers and Committees. Election of Officers.

12:00 Noon—**Luncheon**
Marie Antoinette Room
Address: The Gold Production of the Early Placers of the Northwest—Francis A. Thomson, President State School of Mines, Butte, Montana.

PROGRAMS OF SECTION MEETINGS

Thursday and Friday, Dec. 27, 28

Botany—Zoology Section

Nettie M. Cook, Lewis and Clark High School, Spokane, Washington, Chairman.

E. F. Gaines, State College of Washington, Pullman, Secretary.

THURSDAY, 2:00 P. M.
Elizabethan Rooms B and C.

1. An Interesting Protozoon—Thomas Large, Lewis and Clark High School, Spokane, Washington.

2. A Study of Diatoms of Puget Sound—Ellis B. Harris, Spokane, University, Spokane, Washington.

3. Dwarfness in Wheat—E. F. Gaines, State College of Washington, Pullman.

4. Some Aspects of Our Present High School Manuals in Botany—Floyd W. Gail, University of Idaho, Moscow.

5. Cytology and Genetics of Wheat—Aegilops Hybrids—Albert P. Larson, State College of Washington, Pullman.

FRIDAY, 10:30 A. M.
Tent Room C

1. A Short Method of Determining Nitrate Nitrogen in the Wheat Plant—Carl Larson, State College of Washington, Pullman.

2. Some Fungi of Northern Idaho—R. A. Diettert, University of Idaho, Moscow.

3. The Flora of Benton County, Washington—Harold St. John, State College of Washington, Pullman.

4. The Two Species of Bunt in the Same Plant—W. K. Smith, State College of Washington, Pullman.

5. Gametogenesis in Ditylum—Ellis B. Harris—Spokane University, Spokane, Washington.

FRIDAY, 2:00 P. M.
Elizabethan Rooms B and C

1. Election of Officers

2. The Grand Canyon of the Snake—Harold St. John, State College of Washington, Pullman.

3. Ecological Studies in Yellowstone National Park—Herma Albertson, University of Idaho, Moscow.
School, Spokane, Washington.

4. Is a Cooperative Biological Survey of the Inland Empire Feasible?—Thomas Large, Lewis and Clark High

5. An Investigation of the Enzymes of the Bitter-Root (Lewisia rediviva)—J. W. Severy, University of Montana, Missoula.

6. An Inexpensive Daylight Screen for Projection Apparatus—Thomas Large, Lewis and Clark High School, Spokane, Washington.

Chemistry—Physics Section

Thomas M. Dahm, University of Idaho, Moscow, Chairman.
George F. Clukey, Lewis and Clark High School, Spokane, Washington, Secretary.

THURSDAY, 2:00 P. M. Joint Meeting With the Northwest Section American Chemical Society.
Elizabethan Rooms D and E

1. Teaching of Chemistry in the High School—George F. Clukey, Lewis and Clark High School, Spokane, Washington.

2. Why a Study of Soils is a Science all its Own—W. L. Powers, Oregon State College, Corvallis.

3. Definitions in Physics—Thomas M. Dahm, University of Idaho, Moscow.

4. The Need of More Emphasis on Correct Technique in Advanced Courses in Chemistry—J. A. Kostalek, University of Idaho, Moscow.

5. Quantitative Method of Determining Minute Amounts of Arsenic—J. R. Neller, State College of Washington, Pullman.

FRIDAY, 10:30 A. M.
Tent Room A.

1. Commercial Utilization of By-Products—H. D. Wagnon, Palouse, Washington.

2. Problems Before the Cereal Chemist —J. W. Montzheimer, Centennial Mill Company, Spokane, Washington.

3. Continuation of Report of New Type of Viscometer—B. L. Steele, State College of Washington, Pullman.

4. Properties of Soil Colloids—R. E. Stephenson, Oregon State College, Corvallis.

FRIDAY, 2:00 P. M.
Elizabethan Rooms D and E.

1. Election of Officers.

2. A Laboratory Air Thermometer—B. L. Steele, State College of Washington, Pullman.

3. Soil Temperatures in Forest Areas—George L. Luke, University of Idaho, Moscow.

4. Pole Distances of Bar Magnets—R. O. Hutchinson, State College of Washington, Pullman.

5. Irregularity in the Electrostriction of Quartz Crystals and a Re-Determination of the Piezo-Electric Constant of Quartz—Walter L. Bond, State College of Washington, Pullman.

Education Section

Raymond F. Hawk, State Normal School, Cheney, Washington, Chairman.

S. G. Witter, Principal Part Time School, Spokane, Washington, Secretary.

THURSDAY, 2:00 P. M.
Room 200.

General Theme: Trends in Educational Practice.

1. The Study of Superintendency—C. W. Stone, State College of Washington, Pullman.

2. Purpose and Method in Biological Teaching in Secondary Schools—Thomas Large, Lewis and Clark High School, Spokane, Washington.

3. Secondary Teaching as a Preparation for Study in Higher Institutions—Luther S. Jessman, State Normal School, Ellensburg, Washington.

4. The Junior College as a Part of Washington's Public School System—George W. Wallace, State Normal School, Cheney, Washington.

5. The Prediction Index—John S. Jordan, State Normal School, Ellensburg, Washington.

FRIDAY, 10:30 A. M.
Tent Room B.

General Theme: Trends in Educational Psychology.

1. Child Psychology up to Date—O. C. Pratt, Superintendent of Schools, Spokane, Washington.

2. What a Baby Does—Charles E. Cone, Superintendent of Schools, Ephrata, Washington.

3. Health Habits and Knowledge of School Children—W. F. Standeford, Superintendent of Schools, Burke, Idaho.

FRIDAY, 2:00 P. M.
Room 200

General Theme: Science Applied to Education.

1. Election of Officers.

2. The Present Status of Intelligence Testing—L. N. Madsen, State Normal School, Lewiston, Idaho.

3. Science and Social Practice—William T. Stephens, State Normal School, Ellensburg, Washington.

4. The Educational Program of the National Parks—Herma Albertson, University of Idaho, Moscow.

5. Factors Influencing Scholastic Success—Raymond F. Hawk, State Normal School, Cheney, Washington.

Engineering Section

A. D. Butler, City Engineer, Spokane, Washington, Chairman.

THURSDAY, 2:00 P. M.
Elizabethan Room A.

1. Election of Officers.

2. The Application of Science to Concrete Manufacture—A. M. Philleo, Spokane, Washington.

3. Washboards in Highways—H. V. Carpenter, State College of Washington, Pullman.

4. Zoning, a Phase of City Planning—Harry F. Aumack, Spokane, Washington.

5. The Rising Status of Industrial Research—H. V. Carpenter, State College of Washington, Pullman.

Forestry Section

E. E. Hubert, University of Idaho, Moscow, Chairman.

Gerhard Kempff, University of Idaho, Moscow, Secretary.

THURSDAY, 2:00 P. M.
East Banquet Hall.

1. The Known Extent of Blister Rust in the Inland Empire at the Close of the 1928 Fiscal Year—H. N. Putnam, Office of Blister Rust Control, Spokane, Washington.

3. Temperature and Seed Germination—F. W. Haasis, University of Idaho, Moscow.

4. A Preliminary Study of Defective White Fir on the Payette National Forest in Idaho—E. E. Hubert, University of Idaho, Moscow.

5. Some Notes on the Poisoning of Sheep by Lupines—J. W. Severy, University of Montana, Missoula.

6. Accuracy of Quadrat Sampling in Studying Reproduction on Cut-over Areas—I. T. Haig, Northern Rocky Mountain Experiment Station, Missoula, Montana.

FRIDAY, 2:00 P. M.
Mandarin Room.

1. Election of Officers.

2. A Forest Survey of Benewah County, Idaho—F. G. Miller, University of Idaho, Moscow.

3. Some Phases of the Slash Disposal Problem in Idaho—E. H. Myrick, St. Maries, Idaho.

4. Some Slash Disposal Notes—G. Kempff, University of Idaho, Moscow.

5. Ribes Ecology on Cutover Timber Lands—W. A. Rockie, Office of Blister Rust Control, Spokane, Washington.

6. What is Research?—R. H. Weidman, Rocky Mountain Experiment Station, Missoula, Montana.

Geology—Geography Section

H. E. Culver, State Department of Conservation and Development, Pullman, Washington, Chairman.

Alfred L. Anderson, Bureau of Mines and Geology, Moscow, Idaho, Secretary.

THURSDAY, 2:00 P. M.
Mandarin Room.

1. The Origin of Swauk Gold—John P. Thomas, State College of Washington, Pullman.

2. The Snake River Canyon—F. B. Laney, University of Idaho, Moscow.

3. Geology of the Mission, Swan and Flathead Mountains, Montana—Charles H. Clapp, President University of Montana, Missoula.

FRIDAY, 2:00 P. M.
East Banquet Hall.

1. Election of Officers.

2. Thermal Waters Near Boise, Idaho—Thomas H. Hite, University of Idaho, Moscow.

3. Fossil Ice Crystals—William D. Mark University of Idaho, Moscow.

4. The Lava Creek Craters, Butte County, Idaho—Alfred L. Anderson, Bureau of Mines and Geology, Moscow, Idaho.

5. The Grand Coulee, Joseph C. McMacken, Lewis and Clark High School, Spokane, Washington.

Plant Pathology Section

J. M. Raeder, University of Idaho, Moscow, Chairman.

G. D. Ruehle, State College of Washington, Pullman, Secretary.

THURSDAY, 2:00 P. M.
Tent Room A.

1. Strains of Corticium vagum solani—E. W. Whitman and C. W. Hungerford, University of Idaho, Moscow.

2. The Value of Organic Mercury Dusts in the Treatment of Pea Seed—Leon K. Jones, State College of Washington, Pullman.

3. Telial Germination in P. glumarum—W M. Bever and J. M. Raeder, University of Idaho, Moscow

FRIDAY, 2:00 P. M.
Tent Room A.

1. Election of Officers.

2. Cultural Studies of Stinking Smut—Jesse Kienholz, State College of Washington, Pullman.

3. Dasyscypha fusco-sanguinea Rehm. on Western White Pine—C. R. Stillinger, Office of Blister Rust Control, Spokane, Washington.

4. Seed Transmission of Bean Mosaic—W. H. Pierce, University of Idaho, Moscow.

5. The Fungous Flora of the Normal Apple: The Aspergilli—Glenn A. Huber, State College of Washington, Pullman.

Social Science Section

J. G. Patrick, Spokane University, Chairman.

THURSDAY, 2:00 P. M.
Hall of the Doges.

1. The Kellogg Treaty—E. O. Holland, President Washington State College, Pullman.

FRIDAY, 2:00 P. M.
Elizabethan Room A.

1. Election of Officers.

2. Historic Spots in the Spokane Country—W. D. Vincent, Spokane, Washington.

3. The Idaho Plan of Consolidating State Administrative Functions—T. S. Kerr, University of Idaho, Moscow.

4. Teaching Economics by Three Different Methods (A Comparison With Results of Experiment)—Louis S. Livingstone, Lewis and Clark High School, Spokane, Washington.

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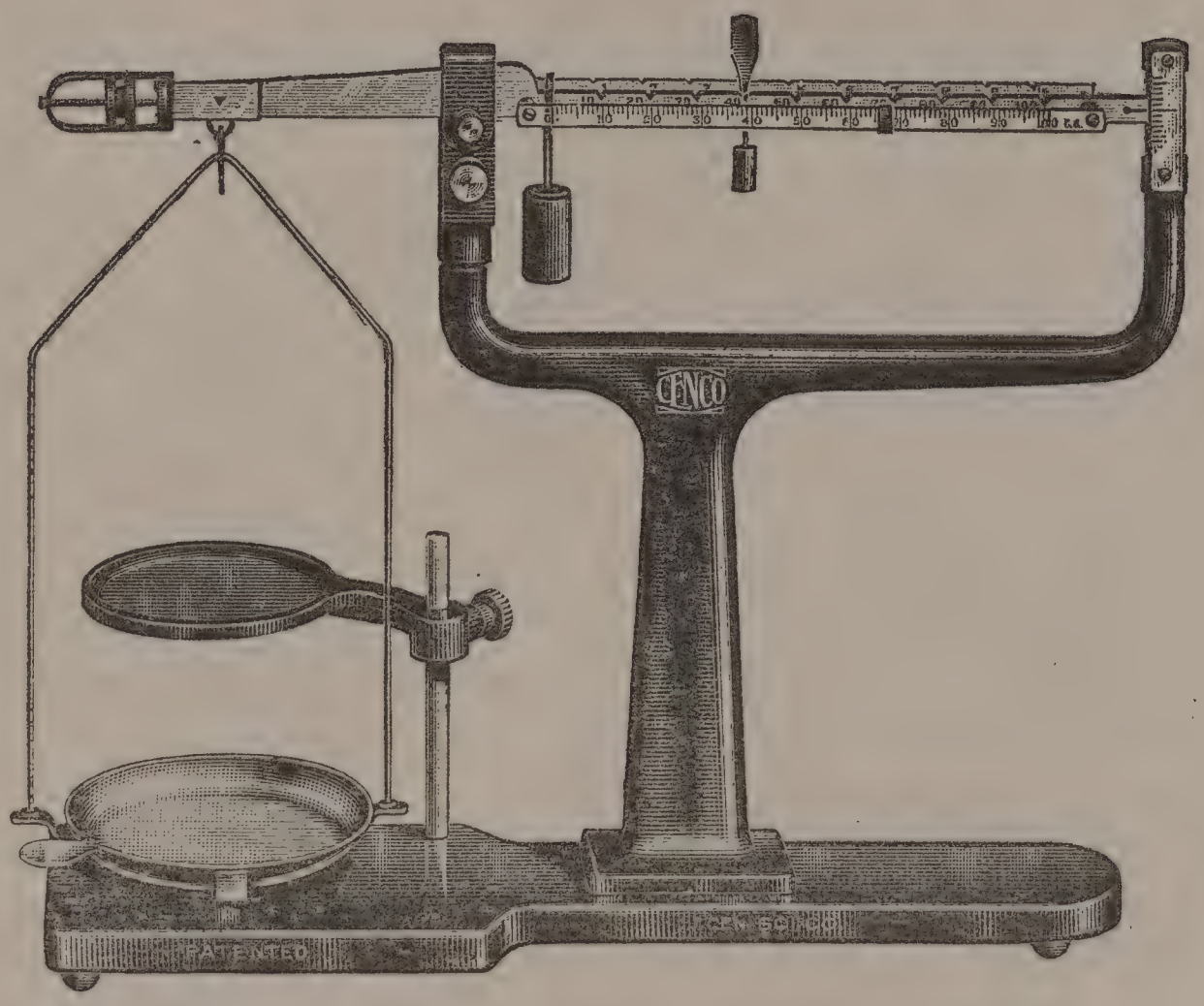

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LOUIS M. DAVENPORT
President

NORTHWEST SCIENCE

Official Publication of the Northwest Scientific Association

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VOL. III MARCH, 1929 No. 1

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NORTHWEST SCIENCE

VOL. III MARCH, 1929 NO. 1

ANNUAL MEETING OF THE NORTHWEST SCIENTIFIC ASSOCIATION

J. W. HUNGATE, *Secretary*

The fifth annual meeting of the Association, held in the Davenport Hotel on December 27 and 28, was attended by 142 registered members. Many visitors also attended the meetings, especially the section programs. Eighty-six papers were presented, 11 of these being given in general sessions, the balance in section meetings.

At the business meeting on December 28 several important changes in the organization were made or announced. The secretary read the proceedings relative to incorporation of the Association and announced that it had been regularly incorporated on May 7, 1928, in accordance with the action of the Association on December 26, 1926.

After unanimous agreement of the Association to consider an amendment to the by-laws the following changes were made relative to membership:

Article III. Membership. Membership in this organization shall be divided into the following classes—

(1) Member. Any one interested in the purpose of the society may become a member on the annual payment of one dollar.

(2) Institutional Member.

a. State Universities, colleges and similar educational institutions. Annual dues $25.00.

b. Normal Schools, other educational institutions and professional organizations. Annual dues $10.00.

(3) Life Member. Life membership may be obtained on the cash payment of $25.00, or by paying $6.00 per year for five years.

(4) Supporting Member. Supporting membership may be obtained by a minimum payment of $100.00.

(5) Patron. Persons contributing $1,000.00 or more to the Association shall be known as patrons.

A resolution was passed voicing appreciation of the services of the late Dr. J. E. Kirkwood in the development of the Association. Resolutions were also passed in commendation of the management of the Davenport Hotel, the press of Spokane and the John W. Graham Company, and others.

The following officers were elected for 1929:

President—John A. Kostalek, University of Idaho, Moscow, Idaho

Vice President—Francis A. Thomson, State School of Mines, Butte, Montana

Secretary-Treasurer — J. W. Hungate, State Normal School, Cheney, Washington.

Councilor, five years—C. C. Todd, State College of Washington, Pullman, Washington

Councilor, unexpired term of, J. A. Kostalek—Ivan C. Crawford, University of Idaho, Moscow, Idaho

Trustee, three years—M. A. Brannon, University of Montana, Helena, Montana.

SECTIONS:

Botany-Zoology—

Chairman—T. A. Bonser, North Central High School, Spokane, Washington

Secretary—R. L. Webster, State College of Washington, Pullman, Washington

Chemistry-Physics—
Chairman—B. L. Steele, State College of Washington, Pullman, Washington.
Secretary—J. L. Sloanaker, North Central High School, Spokane, Washington

Education—
Chairman—I. N. Madsen, State Normal School, Lewiston, Idaho
Secretary—S. G. Witter, Part Time School, Spokane, Washington.

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Geology-Geography—
Chairman—Alfred L. Anderson, Bureau of Mines and Geology, Moscow, Idaho
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Chairman—S. E. Lambert, Spokane, Washington
Secretary—R. E. Stier, Spokane, Washington

Plant Pathology—
Chairman—H. E. Morris, Agricultural College, Bozeman, Montana
Secretary—L. K. Jones, State College of Washington, Pullman, Washington

Social Science—
Chairman—J. G. Patrick, Spokane University, Spokane, Washington
Secretary—Louis S. Livingston, Lewis and Clark High School, Spokane, Washington

ACKNOWLEDGEMENT: To those members and others who contributed to the success of the fifth annual meeting of the Association hearty thanks are extended. This includes those who presented papers, delivered addresses, or discussed them. The members of the local committee gave generously of their time to some advantage they believe and deserve credit. Especial obligation to the railroad companies for reduced rates extended for the first time, the daily and other papers for extensive publicity, the Davenport Hotel management and employees who cared for all the requirements of and incident to the meeting. John W. Graham & Co. for loan of lantern and service of operator, and other courtesies. The Spokane Chamber of Commerce, as usual, gave liberally of their technical staff and otherwise assisted in the event. Others singly and in groups were of great aid. With such a combination and such organization success was well insured. It is gratifying to know that the membership was increased some 30 per cent or more and several educational institutions not before represented were registered and placed upon the membership roll.

SUGGESTIONS for the creation of new sections or any other proposed changes in the Association should be addressed to the Secretary.

AUTHORS OF PAPERS AND ADDRESSES presented before any general or sectional meetings of the Association December 27-28 should send the manuscripts to the Publication Committee, 722 Peyton Building, Spokane, Wash.

The Publication Committee of Northwest Science are not responsible nor claim any credit for statements made in published articles or in discussions pertaining thereto.

NORTHWEST SCIENTIFIC ASSOCIATION: A VISION OF THE FUTURE*

L. K. ARMSTRONG

Consulting Mining Engineer

The first problem with which I was confronted in relation to my retiring presidential address was that of title, and like a good many other anticipated worries, the bridge to span the chasm was laid (by our watchful president) before I arrived. The title selected being "The Northwest Scientific Association: A Vision of the Future"; which reminded me at first sight of some of the double barreled titles of stories so commonly assumed to head the novelettes of my boyhood days which I surreptitiously devoured well hidden behind the covers of my more regular mental diet adopted in the pioneer school room of that time. If by chance there are others here whose memories are stirred by this reference to those bygone days I am edified; if not, then singly and alone, the mental photograph is happily engraved on my memory and is cherished.

Returning to the title of this essay for which I wish first to thank our president as implied evidence of good will, I promise to do as much for him next year—if called upon.

There is more in this title than some of you may surmise. The name of the society brings to mind the circumstance of the christening when those present in serious conclave as to the naming of the infant were somewhat put to it to determine the selection which should most nearly represent the scope,—geographic and scientific—to cover.

Finally, after no little discussion by the more vocal of us who were present, an heretofore silent member-to-be suggested the name ultimately adopted. I have often since wondered, if Mr. Frederic Keffer, the god-father had not been present, what name might have been adopted and how many sessions would have been required to find it. There was also the remote possibility of abandoning the project entirely for you all know by what narrow margins events even so important as this have gang aglee. We owe much to our esteemed fellow member for the well fitting garment as suitable name for our energetic and commendable enterprise. I might continue my rambles around the title by which our society is known but shall leave much unsaid.

The real substance of my address lies in the second barrel, or "A Vision of the Future." The vision was not mine, but rather the creature of others, notably Dr. F. D. Heald, our first secretary and present editor in chief of Northwest Science, our late and much lamented friend Dr. J. E. Kirkwood, who, by the aid of Prof. Thomas Large in the formative period of our existence conceived a broad foundation. Dr. H. S. Brode whose suggestion of precedential details was so useful, the invisible but helpful support of another silent member, Dr. C. C. Todd, and others in lesser degree. To each of these living members we owe much. Our deceased friend Dr. Kirkwood, was able to graphically portray the future possibilities of the Association, whose brush lies ready to hand of the one who may skillfully blend the colors, and through accomplishment, realize on some of the ambitions, the most colorful of all being found in the Vision so clearly decerned by none so well as he.

Vision is the origin of every worth while accomplishment; it is the germ and inspiration from which the wholesome activities of man are derived and it will continue to be the torch which will

*Retiring Presidential Address delivered at the Fifth Annual Meeting of Northwest Scientific Association, Spokane, Wash., Dec. 27, 1928.

dawn the day of every future upward step of humankind to the end of time.

From the vision of the lamented member, his associates and co-workers hereabove cited we have derived inspiration to do things in compliance with the law of sequence, and the few items which I shall speak of should be regarded as the sparking results of such inspiration grandchildren of Vision and so items one degree farther removed from the ultimate source.

Springing from inspiration have been many thoughts as to scope, character, ambition, accomplishment. Just as no child is born of the stature and mental capacity of its parents, so is our Association wanting in number and scope of those accomplishments of which older organizations are possessed; but we are the product of evolutionary processes. We advantage in the prediscovered answers to problems which would otherwise be ours to solve, but profiting by inherited information we are able to advance a step higher, face new problems, solving a few and passing others on with our notations to the host which will follow.

One of the first steps in our career is to discover what is being done in our field, by our members, and by whom. To that end I have recently applied myself by setting in motion an inquiry, first addressing myself to the heads of such educational institutions as I have known to be within our assumed territory, asking them to inform me as to who in their respective institutions are engaged in research. Upon receiving this information I have addressed an identical letter to individuals named asking for details and responses have been gratifying, around two hundred to date. A third letter is even now going out acknowledging receipt of their information.

From these data I hope to be able to present a somewhat modest plan upon which to build a safe foundation for a structure which will be erected in the interest of Northwest Science. I hope I may be permitted to carry on for a time longer with the privilege of calling in assistance or even becoming a member of a committee perhaps, to continue the work of Dr. Kirkwood's committee, if that seems desirable.

I confess to a certain remaining nebulosity as to processes by which to accomplish the things most desired but this fog is less dense as time goes on, the number of replies received and suggestions made aid in dissipating the murk.

Our Association was organized and is proceeding on the theory that man was not made to live alone. In other words, that much is to be gained by the opportunity which is afforded thru this medium for intercourse and exchange of ideas, requires no confirmation. Facilities for the application of these well known facts are desirable and may be improved. Avenues already discovered and applied may be supplemented. The whole regimen may be stimulated and elaborated to the advantage of the group.

Preliminary to the application of any forward movement there must be a liberal cooperative spirit, a desire to aid in the elevation of the whole structure without abandonment of individual effort or accomplishment. The last, but no less important item, is cash with which to carry out the objects sought, which realized, spell success. Cash may be coin of the realm or any other form of assistance of equal value.

I have discovered several important subjects of research even now awaiting or requiring assistance. Among these I find some of which the author should be put in touch with someone else who might be of great assistance in being able to suggest something not touched upon, or who could point out an avenue of information or source of assistance. There are manuscripts which should be available

in the classroom, original manuscripts which contain information of scientific character worthy of a place of public availability. I have found in several cases items which have been published for the consideration of compeers but buried treasures to those who would profit most from the intelligence, a contribution to whom would be much greater in results than to submit to the smaller class alone.

I must not be understood as advocating abandonment of present more common practice, but rather, I wish to call attention of responsibility to the less informed in order that knowledge may be more widely disseminated and diffused and the plane of our common understanding be improved. Good deeds are germs of multiples of fruits, whose eating, increases the desire, which satisfied, results in the greatest good.

My inquiry is but a gesture, one of the many things to be done as preliminary to any sustained effort to further vitalize the Northwest Scientific Association into an agency for the benefit of its members and the public at large,—especially the rising generation. It is a preliminary survey just started, to determine what may be done and how best to increase our ability to do the things desired.

I cannot decently conclude my remarks without thanking those who have been good enough to reply to my inquiries and express the hope that they may be patient if I seem slow or indifferent, as I am not able to move as fast as I wish I might, nor privileged to give the subject continuous consideration in view of other duties and obligations of unavoidable interference.

Another postscript is my hearty congratulation to the secretary for his excellent program and the many details which he has so well cared for. Those who have participated in the entertainment and culture of the occasion have their own reward, but to those also we owe a debt of gratitude which I wish to acknowledge.

I thank you all for having this opportunity to say something in commendation of the work which is being carried on and the ability to point out some of the things which I recognize as outstanding accomplishments thus far realized, with some small measure of ability to forecast a future of increasing interest and mastery of scientific problems.

NOTE ON A NEW TYPE OF VISCOMETER*

B. L. STEELE

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The type of viscometer which is being developed has as its essentially new feature the fact that the coefficient of viscosity is measured in terms of the reading of an indicating wattmeter.

It consists of two concentric cylinders between which is placed the liquid of which the viscosity is to be determined. The inside cylinder is rotated at a constant speed by an electric motor while the outside cylinder remains stationary. The outside cylinder may be either rigidly fixed in position or fixed on a pivot and held stationary by balancing torques.

Formulae are developed from which the coefficient of viscosity of the liquid may be calculated either in terms of the dimensions of the apparatus, the speed of rotation of the revolving cylinder, and the wattmeter reading; or in terms of the dimensions of the apparatus, the speed of rotation of the revolving cylinder and the balancing torques in which latter case the viscometer is used as an absorption dynamometer.

One of the important advantages of the apparatus lies in the fact that the wattmeter reading or the dynamometer reading on the one hand, and the temperature of the liquid on the other may be made practically simultaneously. The value of the coefficient of viscosity is determined therefore for a particular temperature. The coefficient of viscosity is obtained directly in absolute units.

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EFFECT OF PLACER GOLD PRODUCTION ON THE NORTHWEST*

FRANCIS A. THOMSON

President, Montana State School of Mines

The most important event of the nineteenth century in Western America was James Marshall's discovery of gold at Coloma Mill near Sacramento, California, on January 16th, 1848.

Paralleling this discovery in its significance to the Northwest was the discovery in the fall of 1855 of placer gold near old Fort Colville, not far from the present town of Marcus, in Stevens County, Washington.

Those of you who are familiar with the comparison between the production of the California placers and that of the Colville mines may be disposed to challenge this statement, for the placers of California probably produced more millions in gold dust than the Colville placers produced thousands. Nevertheless, in their most significant aspect, these two otherwise dissimilar gold camps served the same surpassingly important purpose, namely that of supplying the stimulus which was necessary to ensure occupation and civilization of the western half of the western hemisphere.

To appreciate the full significance of what Leslie M. Scott has so aptly termed the "pioneer stimulus of gold", let us examine briefly the condition of the country west of the Rocky Mountains in 1847, the year before the discovery of the California placers.

The country had, of course, been the scene of some remarkable explorations, beginning with the Lewis and Clark expedition in 1805-06, but with the exception of some settlements on the Willamette, none of these explorations had resulted in any material occupation of the great empire which stretches from the Continental Divide to the Pacific Ocean.

The northern part, known vaguely as "Oregon", was a country of vague boundaries and vague geography, in fact it is doubtful if there is any part of the earth's surface today concerning which as little is known to the average man as was known of western America in 1847, with the possible exception of the Arctic and Antarctic circles.

The country became essentially a game preserve and quarrelling ground for the Hudson's Bay Company and its competitors. Here and there was a mission, Jesuit or protestant, with its DeSmet or its Whitman in charge, but these were "foreign missions", as it were, whose object was to Christianize the Indian.

At strategic points were "forts" as they were called, usually stockades of logs, set upon end in the ground, with bastions at opposite corners. To these came the trappers with their pelts. Every foot of the fur-bearing country was covered. As the fur-traders tramped the forest they learned of coal, but they never told of it, of copper and of lead, but they kept it secret, voyageurs discovered gravels rich in gold but were enjoined to silence; to publish such tidings would bring people and people drive away the game.

Eventually the British fur-traders drove most of their competitors from the woods and the "Hudson's Bay Company with its silent partner, the beaver," ruled supreme from the British dominion on the north to the Snake and the Columbia on the south. Reliable estimates place the population of Oregon in 1846 at less than 15,000 people, nearly all of them scattered along the Willamette and about Puget Sound.

There is considerable evidence too, that the activities of the fur-trading companies had about exterminated the beaver and owing to this and to the increasing

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hostility of the Indians, many of the fur-trading posts had been abandoned. Indeed, there is some reason to think that by 1846 the population of the Northwest may actually have begun to decline.

Southward of the Snake and Columbia the situation was still worse, the country was too far south to be a good fur country and the people were naturally of a less robust and more indolent type. Because of the known mineral wealth of Mexico, it was supposed there would be mines found in California, but none had been found in spite of the centuries of occupation by Spain and Mexico, and the population of California was less than half that of Oregon at the time of which we are speaking. The story of the California placer discoveries does not belong in this discussion—there has been nothing like it before or since—and there is no probability that there ever will be.

In two years the population of California, in spite of its remoteness, grew from 5000 to 95,000 people, and the California placers produced over $60,000,000 a year for the first ten years after their discovery, or a total of about *1000 tons* of gold.

The first effect was of course, that of a depopulation of Oregon, but gradually the tide began to flow back and men trained in the California goldfields began to search for placer gold elsewhere, particularly in the country to the north.

On the Wenatchee, on Burnt River, on the Coeur d'Alene and the Pend Oreille, on Gold Creek in Deer Lodge Valley discoveries were made but attracted little attention, and it was not until the discoveries near Colville in the spring of 1855 that a gold rush to the north commenced.

As I have already intimated, the gold production was probably inconsequential, but the clashes between the Indians and the miners led to the ultimate subjugation of the Indians through military operations. The establishment of Fort Walla Walla stimulated navigation on the Columbia. The concomitant construction of the Mullan road from Walla Walla to Fort Benton on the Missouri stimulated navigation on that river, and the first steamer from St. Louis reached Fort Benton in 1859.

It was miners working northward from Fort Colville who found gold first on the Similkameen and Kootenay rivers in British Columbia and these discoveries were followed in 1858 by the great rush to the Fraser and the Thompson and then to Cariboo and Cassar.

Meanwhile the warfare with the Indians of the Inland Empire continued until Col. Wright's stern measures of 1853 brought peace to the situation.

As a natural result, prospecting went on again more vigorously on the American side of the line and in 1859 Ed. Pierce, a California miner who had come north to Colville and thence to Similkameen, retraced his steps southward into the Clearwater country and found rich diggings near what is called, in his honor, Pierce City.

By this time the exodus from California to the northward was in full swing—speedily followed by the discoveries at Elk City, Florence, Warrens and other camps in Central Idaho.

From Central Idaho parties spread to Boise Basin and then to Owyhee, where placer mining soon gave place to quartz mining in 1863.

In the meantime, the Californians had invaded Montana and in 1860 James and Granville Stuart were mining at Gold Creek, a tributary of the Clark Fork.

The discoveries up to this point had been almost entirely due to an eastward and northward moving frontier based upon migration from California, but by 1862 the route from the eastern states via the Missouri River and the Mullan road was beginning to be traveled and we find the westward movement meeting the eastward one just east of the Continental Divide in Montana, for in 1862 a party of prospectors moving westward

across Montana to the Salmon River mines discovered gold at Bannock, and in 1863 a party from Bannock stumbled onto rich gold deposits in Alder Gulch, and by 1864 westward moving prospectors had found gold on Prickly Pear and Last Chance Gulch near Helena.

This was the last of the great discoveries until the Klondike in '98.

But emigration had received the stimulus it needed and the future of the west was assured. By 1870 the peak of placer mining production in the Northwest was over, but the harvest had been a good one.

Exact figures were difficult to procure at the time, and the difficulty has not been in any way diminished by the lapse of time, but by a careful study and comparison of all available estimates and by an endeavor to steer between ultra conservatism on the one hand and exaggeration on the other, I have during the last several years compiled the following estimates:

ESTIMATED PLACER GOLD PRODUCTION OF IDAHO AND MONTANA

Year	Idaho	Montana
	In Millions of Dollars	
1860	?	
1861	3.0	
1862	7.0	0.5
1863	9.0	8.0
1864	15.0	13.0
1865	16.0	14.5
1866	17.0	18.0
1867	6.5	12.0
1868	7.0	15.0
1869	7.0	9.0
1870	6.0	9.1
1871	5.0	8.0
1872	2.7	6.0
1873	2.5	5.2
TOTAL	103.7	117.3

This is, of course, a very considerable sum of money, and when we take into account the fact that this amount of gold, together with much of the stupendous gold production of California and of the very considerable gold and silver production of Nevada and Colorado was made in the critical years immediately following the Civil War, it becomes difficult to estimate the importance of such a contribution to the gold and silver supply of the country.

Great as the direct results must obviously have been, however, it is not in my judgment to be compared in importance with the indirect results of the initial stimulus afforded to western development.

To attempt to summarize the remarkable development of the past 80 years in the Empire of Western America would be a colossal task.

To say that an increase in population from 20,000 to 20,000,000 is the direct result of a fortuitous discovery of gold by a man who was not looking for gold, and that the West would today be a howling wilderness but ror Marshall's discovery, would be obviously fallacious, but to say that the placer gold discoveries and production accelerated this process by 50 or 100 years is, I believe, a conservative statement of the case.

These things I think we may safely attribute, however, to the placer mining era:

1. Most of the discoveries and production of lode or quartz mining areas yielding gold, silver, copper, lead and zinc, aggregating probably 10 billions of dollars at a rough estimate, together with the legislation which has made this possible.

2. The beginnings of western agriculture and irrigation.

3. The stimulation of steamboat, highway and railway transportation long before it would have been brought about by any other agency.

4. The application of the sciences of chemistry, physics and geology to the exploitation of mineral resources in a way that no other people have applied them; and

5. Finally, the development of a profession of men trained in the arts and administration of the mineral industry at the very head of which profession stands a man whom this country has honored with its presidency—Herbert Hoover.

RISING STATUS OF INDUSTRIAL RESEARCH*

H. V. CARPENTER

Dean of Engineering and Mechanic Arts, State College of Washington

It was only thirty years before your fathers came over in the Mayflower that twenty-six year old Galileo, a wild young radical, lived in Florence. Here he tried to convince some scholars that Aristotle was wrong in his theory of falling bodies. Strangely he undertook to prove his point by asking them to watch two bodies fall from the Tower of Pisa. They saw but refused to believe!—and this was just yesterday.

Nowadays the pride of workmanship in a fine chair or gown, a great building, a painting, or a fine cherry pie, helps to overcome routine and enlivens life. The successful inventor or research worker gets a still greater thrill for he has not only created something never done before but he has shown the way for others forever after. The modern research worker achieves a new result through patient study of what is known and the application of inventive genius either in methods of work, or in the result, or both. Either a new method of doing something or a new product of research will begin its direct service to mankind everywhere, but perhaps more important than this, may serve as a tool or a guide to further discovery in many fields. The microscope, the x-ray, and photography are good examples of this indirect service and the possibility for wide ramification of results. So the inventor or the research worker has abundant reason for his hope that he may serve his fellow men in a large way.

Fundamental discoveries may be of natural phenomena like the diffraction of light or surface tension or the revolution of the planets, or they may be of fundamental devices based on natural phenomena, like the lens, the compass or the steam engine.

Research takes many forms;—a new basic method in mathematics; an attempt to explain some mysterious set of happenings in nature by establishing a new fundamental law or principle such as the periodic law; or an attempt to determine some well known law or constant more accurately. These are classed as pure research. Research looking toward better instruments, leading to achromatic lenses, microscopes, moving pictures; or looking toward more rapid manufacture, leading to automatic production machinery; or looking toward better transportation, leading to gas engines, pneumatic tires, high strength alloys, electric welding, aeronautics; or better chemical production methods—all this may be classed as practical, applied, or industrial research.

For many years the latter type of investigation has been looked upon by some as being of a distinctly inferior grade, hardly to be listed under the name of research. The passing of this attitude is due mainly to the increased scope and intricacy of the work being done in the industrial research field.

Pioneering of any sort draws together all existing knowledge as a base of operations. When Gilbert studied the magnet, or Faraday felt his way into the field of electrostatics and electromagnetism, this base was simple, almost nonexistent, yet these men worked without guidance and alone and experienced fully the challenge of the unknown. Now, a research in electro-magnetism for example may involve metallurgy, heat treatment, and a host of known magnetic properties and relations which make the prob lem of the modern industrial investiga-

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tor one requiring the fullest mastery of a multitude of natural laws and phenomena.

The simple discoveries relating to known fundamental phenomena and their applications now seem to have been mostly worked out. It is now being said that industrial research has too nearly used up the results of research in fundamentals. While probably true, this is partly a state of mind, since there is no indication that all developments possible have been made in any field. The condition does however make it quite unusual for a simple and easily developed application to be discovered at the present time. In other words new developments are now achieved through much study of previous work, and through difficult tests requiring much special and expensive equipment and trained investigators. The former reluctance of technical manufacturers to undertake the investigations needed to improve and broaden their product is rapidly disappearing; in fact the best investigators are being drawn away from the colleges too rapidly for the best results so far as the supply of well trained men is concerned.

The loss of leadership in the research field by the colleges has been due in part to their attempt to limit their problems to those of the pure research type. Such a limitation has lost much of its former justification since industrial research has become complex. These studies are now frequently just as fruitful in developing men as pure research and so are equally satisfactory for colleges to undertake.

Thus we find the industries undertaking pure research because of abundant resources and the colleges swinging toward problems of the more practical type probably with advantage to both.

While I have not overdrawn the growth in complexity of modern industrial reasearch, there is another phase of it which is equally important. This is the amazing ramifications which develop in many researches that are undertaken, and which lead to many surprising fields of activity for the research worker. For example, it was recently decided to attempt a better method of handling fish and preparing it for market. After an extended biological and physical study it was found that if the freezing were carried on with great rapidity, fish could be frozen without in any way injuring its texture. Now the great fish dealers are cutting away the waste material, placing the fillets or steaks in a freezing atmosphere many degrees below zero and delivering them to customers all over the United States in perfect condition.

Millions are being saved and many business enterprises are being rescued from bankruptcy through intensive studies of materials which were considered waste products. Frequently the value of the products formerly wasted is such that they have become the principal products of the factory so far as revenue is concerned. Waste is of many sorts; not only materials but time formerly wasted has been saved in many ways. Elaborate motion studies of the hand processes have resulted in startling economies, with valuable results both to the worker and to his employer. Evey day some new automatic machine is put in operation which is able to carry out without assistance field before the desired result it attained.

It is not surprising that research of this type frequently furnishes clews to new fundamental data or phenomena or develops processes or devices which are found useful in extending our frontiers of primary or fundamental knowledge of nature's laws. It is in this gradual change the routine movements which formerly required human labor. Usually the automatic machine is much quicker and more dependable than the human operator. Frequently also the change is worth making from the standpoint of safety alone.

Every time the metallurgist, or the chemist, brings out a new material, whether it be a synthetic organic compound, or a stronger or lighter alloy, an entire chain of improvements is set in motion. Machinery must be redesigned,

methods of manufacture altered, production schedules adapted to the new conditions, and probably new automatic machinery developed and built. Such developments as these point out one of the reasons why the leadership in industrial research has been lost by the Universities and transferred to the industries themselves. It is impossible for the institutions of learning to maintain the close contact with all angles of industry needed to make development work of this sort most effective.

That this great readjustment is important is evidenced by a new book just received. Nineteen Industrial Explorers are written up in its pages. Only one of these men is a teacher. Prominent in the book are men like Whitney, who directs the expenditure of millions at Schenectady; Frank B. Jewett, leader of three thousand investigators in the field of communication; Baekeland, who created a new wonder substance; and Sperry, whose gyroscopes and search lights are so near the impossible. The lone college professor is included because he learned how coffee should be made, and I doubt if any of you can name him.

In closing may I remind you of the immortal words of Francis Bacon. "It will not be amiss," says Bacon, "to distinguish the three kinds, and, as it were, grades of ambition in mankind. The first is of those who desire to extend tend the power of their country and its dominion among men; this certainly has more dignity but not less covetousness. But if a man endeavor to establish and extend the power and dominion of the human race itself over the universe, his ambition is without doubt both a more wholesome thing and a nobler than the other two."

HEALTH IS WEALTH*

S. E. LAMBERT

Physician, Spokane, Washington

Statistics now available demonstrate our progress in the preservation of health and the prolongation of life, the enormous cost of sickness and early death. Medical progress has shown us that many diseases are wholly unnecessary and can be abolished at any time the leadership appears and funds are provided. Economic well-being has aided at least one of the major scourges of mankind to diminish rapidly.

The cost of raising and educating an average child to the age of eighteen has been quite definitely estimated at about $10,000 and at that age such a youth is worth not less than $29,000 to the state.

The value of the individuals is five times the value of the physical assets of the nation; 1,500 billions for human beings as against 321 billions of dollars for farms, homes, manufacturers, railways and other material assets.

Costing so much to raise, valuable as they are when alive and well, this sensible, enlightened, progressive nation of ours permits prodigal waste. 120,000 babies needlessly die each year and constantly 2% of the population is too ill to work; as a result of illness many cripples remain to reproach our intelligence and burden the community. The sorrow and suffering cannot be estimated in money but those of us who have experienced them feel that the financial loss is by far the lesser one.

Smallpox, typhoid fever, diphtheria, recently scarlet fever and measles, malaria, and many diseases due to animal parasites, are wholly preventable by means now thoroughly well known.

The cost of this conservation has been estimated at 180 million dollars a year, less than five times the 40 million now their power in their native country; which kind is vulgar and degenerate. The second is of those who labor to exbeing spent from public philanthropic and private funds for the prevention of

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disease and death. Compare this 180 million needed for prevention with the 2¼ billion dollars spent for treatment and 2 billions allowed for education. Yet health is, for any individual, the greatest single factor in success.

We may point with pride to certain very real accomplishments—

The death rate in the first year of life has been reduced from 25 per cent to 7 per cent and can be further reduced to about 3 per cent, saving 120,000 infants annually.

Tuberculosis is rapidly diminishing and probably within another generation will become a most uncommon disease, saving almost all of the 100,000 who now perish each year, as well as a host of cripples, orphaned children and grinding poverty for survivors.

Life has been prolonged from an average of forty years in 1880 to more than fifty-six years in 1927 but it will take us some time to reach the average of sixty-five years already attained in New Zealand. Compare this in turn with India's average life expectation of twenty-five years; 8 million funerals a year.

Intelligent effort, reasonably financed, has demonstrated in Framingham, Mass. in the short time of seven years, that tuberculosis can be practically abolished; in three years' time infant mortality has been reduced from 30 per cent to 8 per cent in a Canadian community where leadership was accepted.

Annual physical examinations have reduced the death rate 18 percent for a very large group and are available for all at a very slight cost.

Among some of the great problems of life and health, and hence of wealth, no solutions have been promised us. We have the common cold which causes about 45 per cent of the total sickness each year; cancer is increasing more rapidly than longevity; automobile accidents are mounting as lethal causes; heart disease at least keeps pace with lengthened life; pneumonia seems to be less prominent.

Interesting side lights on statistical studies of vital statistics show that—

Women live longer than men.

Of 1000 women 788 marry and 654 become mothers.

Without immigration and the large families of young immigrants our population would remain nearly stationary. Our intelligentsia already practices birth control to a degree that is near the border line of safety to the state.

Negroes live almost as long as whites.

During the world war the tuberculosis death rate of Vienna rose from 302 to 425; that of Belgrade rose 1400 against that of 80 per 100,000 for the United States during 1920. So it appears quite definite that peace and reasonable prosperity are great aid in eliminating tuberculosis.

Due to the influx of young immigrants only about 5 per cent of our population are over sixty-five years of age, a normal would be 10 per cent and ultimately will be a problem needing serious consideration; however only about 15 percent of the aged at present require public support.

Three score years and ten remain the span of life.

In conclusion—We have done much, we can do more; early deaths, a high percentage of which can be prevented, are a stupendous financial loss.

Indebtedness to Dr. Louis I. Dublin, statistician of the Metropolitan Life Insurance Company, is acknowledged for most of these statistics and to the Metropolitan Life Insurance Company is given credit for statistics and many forward looking efforts toward life saving and physical betterment. To the medical profession, the progress of which has made these improvements possible, we may look for further aid.

LAVA CREEK VENTS, BUTTE COUNTY, IDAHO*

By Alfred L. Anderson

Dept. Geology, University of Idaho

Perched high above the north margin of the Snake River Plains of southern Idaho in Butte county are some volcanic vents from which basaltic lava has cascaded down the mountain sides into the valleys and from one of the valleys out upon the vast lava plain that covers such a large part of southern Idaho. These vents are of interest, not only because they have such a unique position high on the flanks of the mountains, but also because they are an extension of a line of craters on the Snake River Plains which are grouped along a great fissure or rift. The lavas have issued from along this "Great Rift", building up a line of lava and cinder cones some of them so recent and exhibiting such a remarkable freshness that the United States Government has set part of the area aside as a National Monument. (1.)

The Lava Creek vents are four and one half to six miles distant from the apparent termination of the rift at the base of the mountains where the latest volcanic activity has occurred and it was not until the adjoining region was studied and mapped by the writer during 1928 that a relation of the Lava Creek vents to the line of craters in the Monument was established. As the Lava Creek vents are several miles back in the mountains, it was possible to definitely relate the great rift or fissure which has controlled the grouping of the lava vents to structural lines in the mountains and thus determine also the probable relation of the line of craters to concealed structural lines beneath the Snake River lava plain.

The occurrence of volcanic vents on the flanks of the mountains from which lava has cascaded down the steep slopes below has been mentioned by Russell (2) who referred to the flow as the Martin Lava Stream from the name of the post-office at the mouth of the valley. This feature has later been mentioned by Umpleby (3) who applies the name "Lava Creek" for the flow as well as for the district.

Geologic Setting

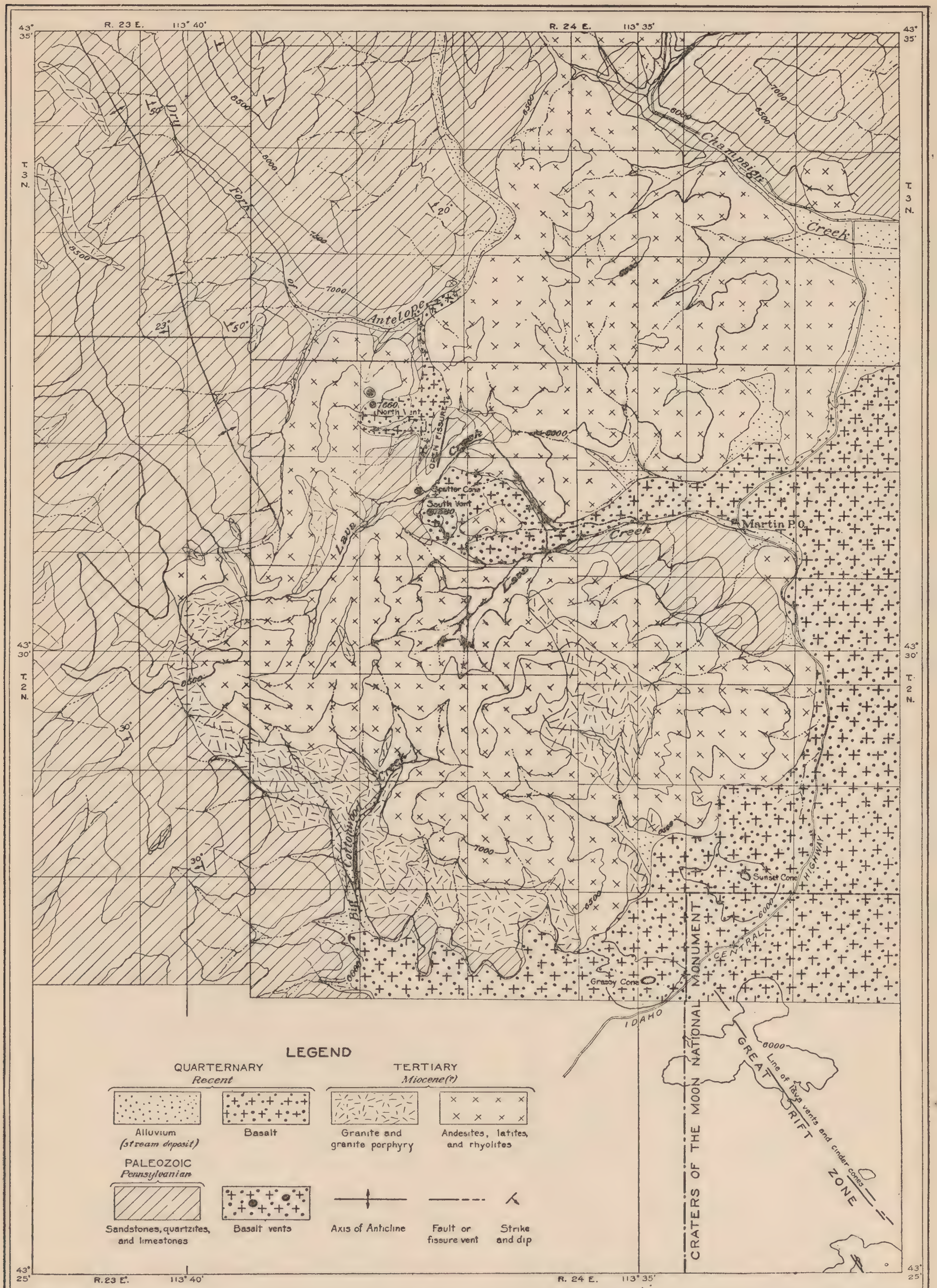
The Lava Creek Vents are perched near the summits of ridges of a maturely dissected mountainous group known locally as the White Knob Mountains that has been carved in Pennsylvanian sandstones, shales, and limestones, and in Miocene volcanics including rhyolites, latites, and andesites. The Palezoic formations have been deformed by folding and faulting, probably first in the late Mesozoic, and then again together with the volcanic series, which filled ancient valleys carved in the older sedimentaries, in the mid-Tertiary, or perhaps at a little later time. The second period of deformation was accompanied by igneous intrusion and the subsequent erosion has brought to view several bodies of a pink-

*Presented at the Fifth Annual Meeting of the the Northwest Scientific Association, Spokane, Wash., December 27-28, 1928.

1. For a description of the many interesting volcanic features in the Craters of the Moon National Monument, the reader is referred to:
   I. C. Russell, "Geology and Water Resources of the Snake River Plains of Idaho," U. S. Geol. Survey Bull. 199 (1902) pp. 72-110.
   "Notes on the Geology of Southeastern Idaho and Southeastern Oregon," U. S. Geol. Survey Bull. 217 (1903) pp. 38-47.
   R. W. Limbert, "Among the "Craters of the Moon," Nat. Geog. Mag. Vol. 45 (1924) pp. 303-328.
   H. T. Stearns. "Craters of the Moon National Monument (Idaho), Geog. Rev. Vol. 14, No. 3. pp. 362-372, 1924.
   "Craters of the Moon National Monument, Idaho, Idaho Bureau of Mines and Geology, Bull. 13 (1928) pp. 5-24.

2. I. C. Russell, "Geology and Water Resources of the Snake River Plains of Idaho," U. S. Geol. Survey Bull. 199 (1902) p. 68-69.

3. J. B. Umpleby, "Geology and Ore Deposits of the Mackay Region, Idaho," U. S. Geol. Survey, Prof. Paper 97 (1917) p. 36.



Topography and Geology
By Alfred L. Anderson
1928

GEOLOGIC MAP OF LAVA CREEK DISTRICT

Scale
1 0 1 2 Miles.

Contour interval 500 feet
Datum is mean sea level

TRUE NORTH
MAGNETIC NORTH
19°
APPROXIMATE MEAN DECLINATION 1925

Drafted by
F.E. Thackwell

ish porphyritic granite and granite porphyry which cut both the Palezoic rocks and the Miocene volcanic series. The physiographic development is not clearly decipherable within the area, but erosion has produced a maturely dissected mountainous mass with a maximum relief of about 3770 feet from where Lava Creek flows upon the Snake River Plain to the top of Blizzard Mountain, the highest peak. The structural features of the mountains and their relation to the recent volcanic activity will be considered in another place.

The Vents

Only two of the vents are of consequence, one of them being the source of a great quantity of lava that flowed into the valley of Lava Creek and out upon the Snake River Plains. This vent, the most southerly and nearest the National Monument, is designated as the South Vent. The second is nearby, but the quantity of lava from this vent is small and flowed into the valley of Dry Fork of Antelope Creek on the north. This vent is designated as the North Vent. Between the two is a small spatter cone that is worthy of description though it did not contribute to the lava flows.

South Vent: This, the most interesting as well as the greatest of the vents, is perched near the terminus of a ridge at an elevation of about 7580 feet. This vent has a small cone of explosive material. The cone is composed largely of black to reddish cinders and of reddish scoria, but lava breached the side of the cinder cone near its base on the north and east and poured into the valley of Lava Creek, the two streams which united as one some distance lower of the valley side. The cinder cone lacks a distinct crater and is essentially a rounded hill of loose cinders with some larger volcanic bombs resting 120 feet and more about the fissure from which the lava issued. There are no mounds or cones where the lava comes to the surface. Small pine trees cover parts of the cinder cone, but much of the cone is free from vegetation and appears remarkably fresh showing little or no evidence of erosion. The cone rests in part on an eroded surface of tilted Pennsylvanian limestone and in part on Tertiary acid volcanics. The base of the cone covers about one-fourth of a square mile.

The lava which apparently issued quietly after a short period of explosive activity cascaded into the valley of Lava Creek, descending 1500 feet in about one mile and then flowing with a lesser gradient out upon the Plains three and one-half miles to the east. The total descent of the lava is about 1900 feet and the length of the flow more than six miles. On entering the main valley of Lava Creek, the flow was restricted by the narrowness of the valley to about 400 yards wide but flares toward the mouth of the valley and spreads widely where it enters the Plain. The drainage was generally deflected to the side of the valley, though in one place the stream crosses the surface of the basalt to the other side but without trenching the lava surface. The vent is recognizable from a distance by the reddish color of its rock. Otherwise, it is relatively inconspicuous.

North Vent: This vent is likewise most conspicuous as a cinder cone perched or built up near the crest of the ridge about one mile to the northwest of South Vent and separated from it by the main tributary of Lava Creek. The cinder cone lies to the front or east of the lava vent and has an elevation of about 7660 feet. This cone is smaller than the South Cone, and, unlike the South Cone, the lava has issued from behind and has flowed into gullies on either side. The cinder cone is similar to the first cone, composed of loose cinders and volcanic bombs partially covered with vegetation, but clearly recognizable by its dark reddish

and black color against the background of the lighter-colored, older rocks. This cone lacks the roundness of the other and comes nearly to a point. The lava vent lies about 350 yards to the west of the cinder peak at about the same elevation, resting directly on the Tertiary volcanic formation. It is probable that the cinder cone was much larger and that the lava carried much of it away. A small crater is preserved on this vent shown by a depression several feet below the outer rim, and outlined by the reddish color of the basalt. The crater is about 80 feet in diameter.

The lava flowed steeply on both sides of the cinder cone into the valley about 960 feet below. The south edge of the lava completely obstructed a minor valley and caused the drainage to be deflected over a low saddle into the main Lava Creek Valley on the south. A tongue of basalt also extended into this depression, but none of the lava entered the main valley. Other drainage changes were inaugurated as shown on the accompanying map. The main flow, however, did not enter the Lava Creek drainage though in two places it nearly spilled over, but the basalt passed to the north for about one-half mile and entered the valley of Dry Fork, following the valley for about one-half mile. The end of the flow rises wall-like across the valley edge. The maximum length of this lava flow is about one and one-half miles.

A second vent lies about 100 yards to the northwest in direct line with the others. This vent is of the same character as the North Vent, but it furnished only a small quantity of basalt, none of which flowed down the valley side.

SPATTER CONE: This interesting little feature lies in the valley floor of Lava Creek between the two large vents. This small cone has been built up by reddish lava clots to a height of about 30 feet and is roughly circular in outline. No crater is preserved at its top. Some reddish cinders and scoria occur with larger fragments of ejected material, but much of the cone is composed of lava clots that have fallen on its sides and of thin streams of lava that have trickled over the surface of the cone. No lava extends from its base.

This spatter cone occurs directly between the two larger vents and in line with them, and this fact also suggests that all are on the same rift or fissure.

CHARACTER OF LAVA SURFACE

The lava, in descending the steep slopes below, formed veritable cascades, and on cooling was left with an excessively rough surface. The crust first formed was broken and the fragments were cemented together by still plastic lava so as to make up in part a course breccia. Many masses of fragmental crust were carried far down the stream and out on to the border of the Snake River Plains. The rough surface of the lava is characteristically that of the aa type and this character is preserved throughout the entire flow even on the Plains where the movement was relatively slow and sluggish. The original rough, jagged surface was further broken by the settling of the crust where lava drained from below. The rough surface has been in part modified by an accumulation of soil which has filled in some of the crevices or cracks in the lava, but the more jagged parts still remain much the same as when the lava cooled. The flows are generously clothed with sagebrush which has gained foothold in the soil in the cracks or on small alluvial plains built on parts of the lava flow in front of some tributary valleys. The lava has lost some of its original freshness when compared with the very recent flows in the Monument, but the surface shows slight signs of weathering.

PETROGRAPHY OF THE BASALT

The surface of the basalt is generally glassy or scoriaceous, but this shell is relatively thin and a well defined crys-

tallinity may be detected in broken fragments of the lava crust. The crystals are of minute size near the surface but even a very short distance inward the basalt becomes relatively coarse grained and the crystals of plagioclase are recognizable. A few large crystals of glassy feldspar are scattered as phenocrysts in some of the rock. These were carried up in the molten magma from below and did not develop at the time the basalt crystallized at the surface. The basalt is generally vesicular, especially near the upper surface and the vesicles range from microscopic sizes to cavities several inches across. The basalt shows little sign of alteration by weathering and the broken surface is dark gray, nearly black.

Thin sections of the rock examined microscopically show that it is a normal, olivine-free, basalt. The basalt has a pronounced ophitic or diabasic texture with small crystals of augite and a dark glass filling the spaces between the acid labradorite laths. The laboradite is the most abundant constituent, though closely followed by augite and glass. Parts of augite crystals tend to merge with some of the glass and it is probable that the glass represents the augite that did not have the time or opportunity to properly crystalize. Magnetite in minute cubes is an abundant accessory, comprising several per cent of the mineral constituents.

Relation of the Lava Creek Vents to the Craters of the Moon National Monument

An inspection of the map will show clearly that the Lava Creek vents are in direct line with a continuation of the chain of cones and craters in the Monument which are grouped along the Great Rift. Mention has been made heretofore of the arrangement of the Lava Creek vents in a straight line which suggests their grouping along a fissure or rift. The Monument cannot be seen from the Lava Creek vents nor can the Lava Creek vents be seen from the Monument because of a high intervening ridge and it is probably for this reason that the relationship between the two had not been established previously, until both had been accurately mapped. The South Vent is four and one-half miles from the most northern vent in the Monument. The rift or fissure cannot be traced between them, probably because erosion on the high intervening ridge is too rapid to permit such a fracture to remain unfilled nor is the nature of the rift such as to form a topographic expression or influence erosion. Curiously, eruption occurred at these two rather widely spaced localities.

Nature of the Rift

The rift along which volcanic activity has occurred shows but little displacement where it is exposed at the surface. In the Monument the rift is not a continuous fracture so far as can be determined, but occurs as a great rift zone comprising several parallel fractures along which several rows of craters now trend. These fissures have been reopened several times and where the lava failed to well up in them remain as more or less open clefts. These fissures may be traced across some of the older flows and in such places show very little displacement. They are more truly great cracks in the earth's crust.

The Lava Creek vents show no definite fissure connecting them. Erosion of the Tertiary volcanics is particularly rapid in the high mountainous region and fissures could not remain open long. An exception to this is an open fissure that crosses the limestone ridge between the South Vent and the North Vent. This fissure, a great open vertical crack crosses the low ridge, forming in part a gaping chasm 4 to 6 feet wide and undetermined depth. This crack may be traced for several hundred yards, but lower on the valley sides it has been filled with erosional products and in the valleys by silts. However, this open fissure is not

in line with the two vents, but occurs nearly at right angles to the line that connects them, striking approximately N. 35°E. It is, however, in direct line with the South Vent and it is not at all improbable that the location of the South Vent has been determined by the intersection of this fissure with the main structural rift and that this open fissure represents a complimentary set unfilled by lava.

Age of the Lava

The basalt from the Lava Creek vents is reasonably young, perhaps only a few thousand years old. Weathering has scarcely affected the surface, if at all. The cinder cones have not been dissected, the cinders have not been cemented, nor have the streams cut into the lava. The flows are covered in part by a thin mantle of soil though great patches of barren lava also occur. Sage brush grows nearly everywhere on the flows. This lava is older than the very recent lava of the Monument which Stearns (4) intimates was poured out more than 250 years ago and probably less than 1000 years ago. But in the Monument Stearns distinguishes three main epochs of eruption, the earliest "long before Egypt had a name" produced a long line of cinder cones and thick jagged flows, consisting largely of broken blocks. Much of the lava and most of the cinder cones in the Monument belong to a younger, second epoch, which was followed soon after by the very youngest flows of the third epoch. The basalt from the Lava Creek vent is greatly similar to some of the older flows in the Monument and was probably poured out during the first great epoch.

Relation of the Great Rift to Tectonic Lines

When the direction of the "Great Rift" is compared with the direction of the trend lines of the older rocks in the region a striking parallelism is noted. The direction of the "Great Rift" is approximately N. 35°W. and this about corresponds to the strike of the Palezoic formations some distance from fault lines or intrusive contacts. It is about parallel to the axis of an overturned fold that is shown to the northwest of the Lava Creek vents and about one and one-fourth mile west of the extension of the rift up Dry Fork Valley. It is nearly parallel to an anticlinal axis in a broad fold of the Tertiary volcanics. The rift is also parallel to many faults in the older formations that are not shown on the map. Other faults occur at approximately right angles to the rift or about parallel to the complimentary fissure across the limestone ridge. An alignment is also shown with the Tertiary intrusives, for most of the stocks and dikes are elongated in a direction which approximately parallels the "Great Rift", though a few smaller dikes occur nearly at right angles to this direction.

Thus the Great Rift bears an obvious relationship to earlier trend lines, and this direction has been one of weakness from the first recognizable folding and faulting in the Mesozoic to the present day. Whether the forces that have produced the folds and fractures have been always from the same direction is not so clear, and there is some evidence to the contrary, but the early trend lines have exerted a control in subsequent movements.

Conclusion

The Lava Creek vents perched high and well back in the White Knob Mountains of Idaho are an extension of a line of cones and craters on the Snake River Plains that are grouped along a great rift or fissure. This great fracture of relatively recent date follows earlier lines of weakness and is approximately parallel to the trend lines in the older rocks developed in Mesozoic and Tertiary time. Thus this direction has been one of weakness from the Mesozoic to

4. Op. Cit. pp. 19-21.

the present day and has served to localize the recent volcanic activity of the region.

AN EFFICIENT LABORATORY OZONIZER*

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In an investigation of the effect of ozone upon unsaturated organic compounds undertaken in this laboratory, it was found necessary to construct an ozonizer yielding a high concentration of ozone in order to bring about certain reactions. This paper is a description of an apparatus that will yield nearly 18% of ozone, and can be easily assembled.

Chemical literature contains numerous descriptions of ozonizers, but many can be assembled by expert glass blowers only, and hence become quite expensive. The apparatus described in this paper cost about $100. It is similar to those described by Briner, Patry, and de Luserna [Hel. Chim. Acta, 7, 62 (1924)] and by L. I. Smith [J. Am. Chem. Soc. 47, 1844 (1025)] with some modifications. The ozonizing tubes consist of three Berthelot tubes of the same dimensions and type as described by Smith and illustrated in Fig. I. The outside tube A is 4.5 cm. in internal diameter and 45 cm. in length, into which is sealed an inner tube B 3.9 cm. in external diameter and 48 cm. long, in such a way that the annular space between the two tubes is 3 mm. Into the outside tube are the intake tube I, and the outlet tube O of O.5 mm. glass tubing extending about two centimeters above the top of the inner tube. The glass is about 0.8 to 1.0 mm. in thickness. These tubes were constructed by the Central Scientific Company of Chicago.

*Presented at the Meeting of the Northwest Scientific Association, Spokane, Wash., Dec. 28, 1927.

The electrical transformer is a Thordarson 1 K. V. A. radio transformer operating on a 110 volts, 60-cycle current, rated to deliver a 25,000 volts current in the secondary. This voltage was found to be too high so a resistance consisting of seven carbon filiment lamps connected in parallel was inserted in the primary circuit. This reduced the voltage in the primary to 50-52 volts, and presumably reduced in the secondary to about 11,000 volts. The current consumption was practically constant amounting to 1.32-1.34 amperes.

The container for the Berthelot tubes consists of a galvanized iron tank 12x16x21 inches provided with a wooden cover 5x16 inches. There is soldered to the bottom of the container a piece of galvanized iron, bent thus _|‾‾‾‾|_ provided with three holes about 3 cm. in diameter having a side slit to fit the intake tube and spaced in such a way that a two-holed rubber tube stopper will accommodate the intake of one and the outlet tube of the next Berthelot tube. This serves as a support for the ozonizing tubes. The cover is provided with holes about 4.2 cm. in diameter, spaced the same as the support, serving to hold the upper ends of the tubes in place, and a set of smaller holes to accommodate the inlet and outlet tubes.

The apparatus is assembled as in the accompanying diagram (Fig. 2). A circular piece of rubber, having a hole in the center sufficient to fit the intake tube is used as a cushion for the Berthelot tubes. The cover is held in place by a galvanized iron bracket soldered to the side of the tank. After the Berthelot tubes have been placed in position, the projecting inlet and outlet tubes are inserted through a two-holed rubber stopper. The tubes should project two or three centimeters through the stopper. A piece of glass tubing of sufficient diameter to fit the stopper and about three cm.

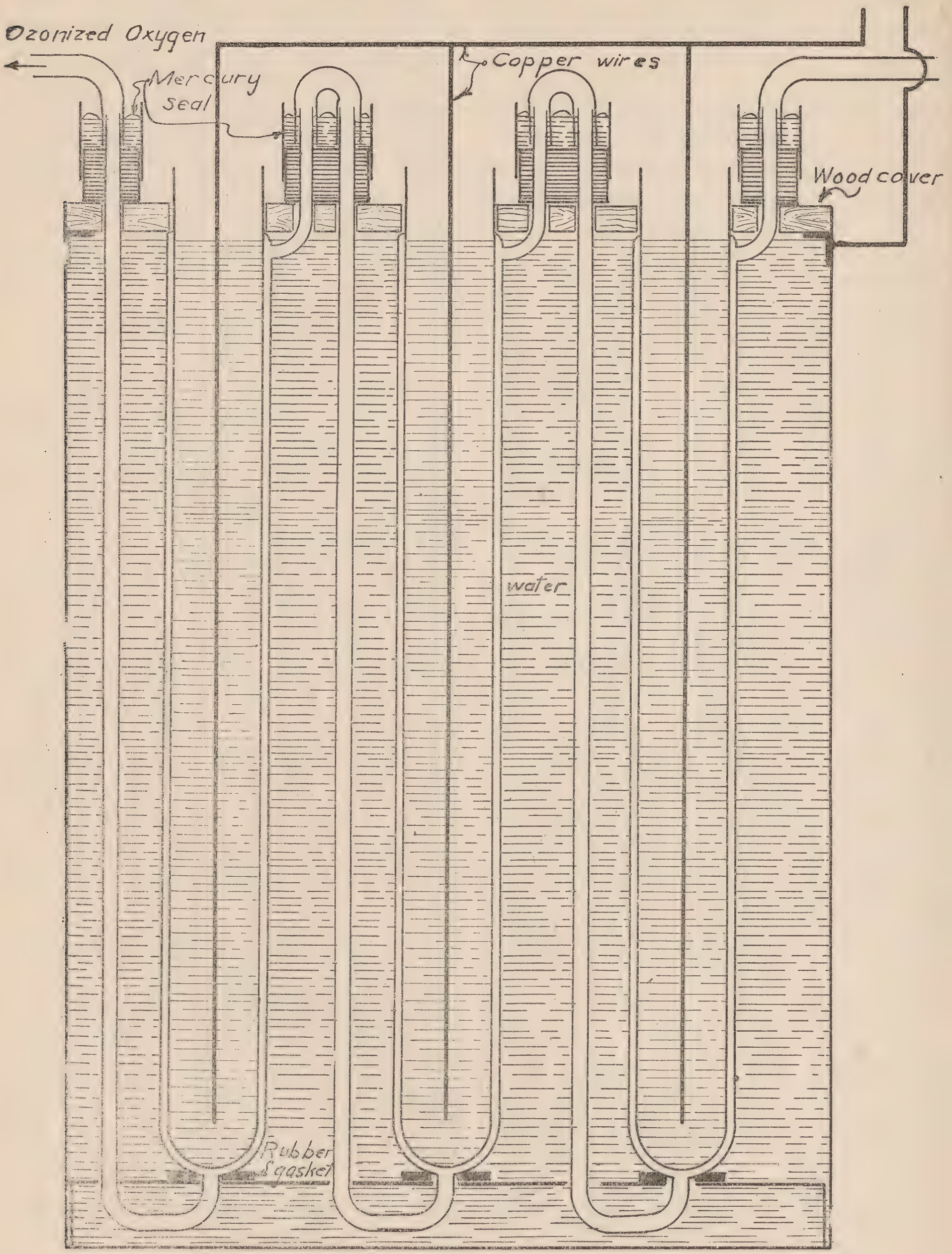

Fig. 2.

Assemblu of Berthelot Tubes

in length, is placed over the stopper. Another glass tube of sufficient diameter to accommodate the inlet and outlet tubes is bent into a U . This is used to connect the two tubes. A little mercury is poured into the larger glass tube. This forms a perfect seal and obviates sealing the glass tubes together. Furthermore, the apparatus can be taken apart at any time without cutting glass connections. For the inlet tube of the first and outlet tube of the last Berthelot Tubes single holed rubber stoppers are used.

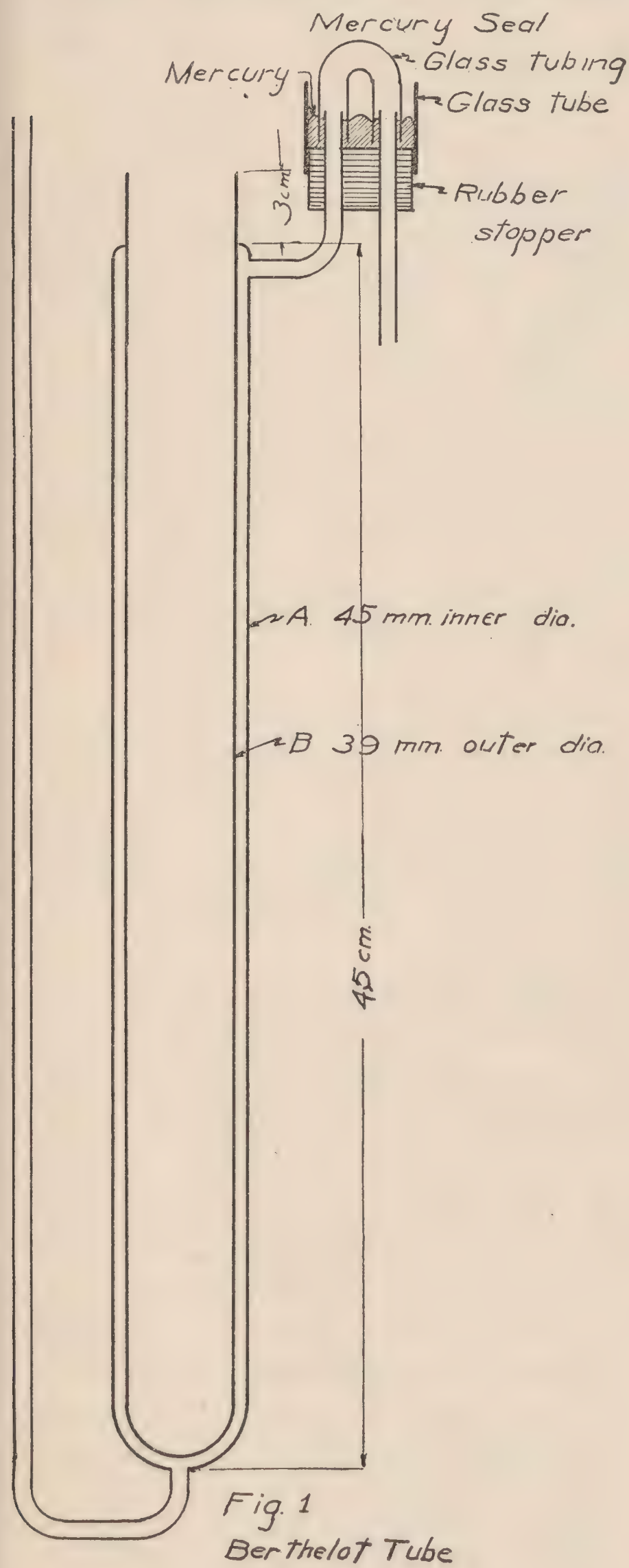

Fig. 1
Berthelot Tube

The inlet tube is connected to a set of four drying tubes consisting of the outer jacket of an ordinary Liebig condenser. Each of these is filled out half full with phosphoric anhydride. The fifth tube contains sulphuric acid, which serves as an indicator of the rate of passage of oxygen through the apparatus. The drying tubes are connected with heavy-walled rubber tubing, coated with the outside with paraffin. The lower end of each of the tubes is sealed together in a Bunsen flame, while the upper ends are closed with rubber stoppers coated with paraffin. A wad of glass wool is placed in each of the phosphoric anhydride tubes so as to prevent it from entering the narrow side tubes and clog up the passage.

A drying train of this type has been in operation nearly a year without any change and it has been found quite satisfactory, delivering a dry current of oxygen. The oxygen used was a commercial product, no experiments have been performed using air, since it is known that air will give a much lower percentage of ozone.

The inside of the Berthelot tubes are filled with distilled water, up to the outlet tube. The galvanized tank is filled with water to the same height. Heavy copper wires are suspended in each of the inside Berthelot tubes and these in turn connected to the transformer. The second terminal of the secondary is connected to the tank. Using water as a conducting medium is a distinct advantage over other types of ozonizers. In the first place, it obviates the necessity of coating the inside and outside the inside tube as recommended by L. I. Smith. It also enables one to regu-

late the temperature, by inserting a coil in the tank and connecting it with the water supply. Though this has not been found necessary since the temperature of the water in the tank has been found to be only a few degrees above room temperature when the apparatus is in continuous use.

Determination of Yield of Ozone

The ozonizer was started and a regular flow of oxygen through the same was maintained for at least one hour before each determination. The outlet tube was connected by a mercury seal to a gas absorption bottle containing 40 cc. of 5% solution of potassium iodide. Ozone reacts quantitatively with potassium iodide according to the following equation:

$$O_3 + 2KI + H_2O — I + O_2 + 2KOH$$

The outlet tube of the absorption bottle was connected to a gas meter calibrated to .01 cu. ft. The time was taken by means of a stopwatch.

The potassium iodide solution was acidified and the liberated iodine titrated with 0.1097 N sodium thiosulphate. The following table gives the per cent of ozone for the different rates, and the corresponding grams per hour.

Rate of flow in liters per hour	Per cent of Oxygen by weight	Grams per hour
.1	12.2	.02
.3	17.6	.05
.66	17.74	.17
1.16	16.6	.28
1.5	13.0	.3
2.7	12.36	.51
3.7	12.42	.64
10.	11.25	1.52

A series of determinations were made in which the voltage in the primary circuit was lowered, but it was found that the per cent of ozone was decidedly lower per a given rate. Increasing the voltage decreased the yield as well.

AT THE LAST MEETING OF NORTHWEST SCIENTIFIC ASSOCIATION, Thomas Large, professor of zoology at Lewis and Clark High School, Spokane, exhibited and made use of a home-made daylight screen for film projection which cost about $2.00. It consisted of a wall board 4 x 5 feet coated with aluminum paint and its adaptability was demonstrated in the fact that it was in constant use during the sessions where a screen was required.

The paper entitled "The Effect of Changed Environment on a Pure Line of Plants", presented December 27, 1928 before the Northwest Scientific Association, by Dr. Alfred Atkinson, was a short presentation of a paper entitled "A Biometrical Analysis of the Effect of Environment on a Pure Line of Oats", which appeared in the Journal of the American Society of Agronomy, Vol. 20, No. 12, December, 1928, as a joint contribution of Alfred Anderson and H. H. Love, a copy of which is filed in the editorial department of Northwest Science.

REVISION OF MEMBERSHIP: A revision of terms of membership of the Northwest Scientific Association is indicated below, the only class of membership heretofore existing being the first in the table. Those following are new classes:

Members per annum	$ 1.00
Life Members, cash	$ 25.00
Or 5 annual payments @ $6.00	$ 30.00
Institutional Members Annually:	
First Class	$ 25.00
Second Class	$ 10.00
Supporting Members, Annual	$ 100.00
Patrons: Minimum Contribution	$1000.00

While no specifications have been made as to how these greater membership sums may be used or applied, the Council will doubtless soon decide on this feature so that the members of the Association and others will soon be in a position to aid in financing it.

NATIONAL FORESTS: THEIR PART IN STATE DEVELOPMENT*

By John D. Guthrie

Public Relations, U. S. Forest Service

The forestry history of the United States is an interesting story—with a little humor in it at times, some pathos, and much of tragedy.

Jenks Cameron's new book (1) tells of that story in a striking and intensely interesting manner. Some readers may say it is written too much in the modern debunking style; perhaps the American forestry movement and also the American lumber industry need debunking. His chapter headings alone are intriguing:—"The Legend of Inexhaustibility", "The Broad Arrow", "The Era of Magnificent Plundering", the "The Era of Magnificent Indignation", "The Forest and American History", etc.

I commend Camerons's book to every thinking American, especially every Westerner. But I shall not deal too much with the historical backgrounds, but rather present-day actualities,—the National Forests as we have them today. And the National Forests are actualities certainly in the 11 Western States, and are playing their part in the economic life of these states, and this part will become more and more important as the years pass.

Here it may be well to ask, and answer, the question "What is a National Forest?" Too often, there is too hazy a mental picture of the National Forests in the public mind; it must be admitted that the physical National Forest picture is also too often blurred by a haze.

A National Forest is an area of government-owned forest land set aside for the growing of trees and the protection of water flow; these are its functions as set down in the basic Act of Congress of 1891. Later Congressional acts clarified and extended the functions of the National Forests, but detracted nothing from the two fundamental functions of timber production and stream protection. Forestry has been defined as the growing of successive wood crops for human needs; that is the first great National Forest function. Protection of stream flow, whether the water is used for domestic or municipal supplies, or whether for irrigation or the generation of electricity, is the second basic function. Rarely in the utilization of these two resources is there a conflict.

A forest may serve both these needs and yet have other functions or by-products. For example—the National Forests have the by-products of forage (grass), game and fish (state property), and recreation. Here a conflict of uses may and often does, occur. To be specific, shall ripe timber be withheld from harvesting because to do so would detract from its recreational or esthetic appeal? Should the annual crop of grasses and wild plants be withheld from utilization into beef, mutton, wool and leather, because campers and nature-lovers wish to view nature undisturbed? Shall livestock, which supplies mankind with many daily necessities, be excluded from the forest scene in order that deer, elk, bear and other wild life may enjoy the solitudes? Shall the National Forests be kept as wilderness, as game refuges? Or must they serve only their primary functions of growing tree crops and protecting water? Or can not there be a correlation of all these apparently conflicting demands into one harmonious entity? Could not a forest be so managed as to produce successive tree crops; protect springs and streams arising with-

*Presented at the Fifth Annual Meeting of Northwest Scientific Association, Spokane, Wash., December 27-28, 1928.

1. Development of Government Forest Control in the United States" by Jenks Cameron, Institute for Government Research, Johns Hopkins Press, 1928.

in it; the forage on its meadows and high open ridges be used by domestic stock; deer and other wild life find refuge and breeding place within it; and the camper, hunter and fisherman enjoy its greenness, its coolness, its game and its fish?

They seem to have accomplished this Utopia in many European forests, but then many of their forests have been under management for 250 years and over, while the U. S. Forest Service is less than 25 years old. Forestry is a long time matter, we must admit.

These are some of the forester's problems, to decide what to do, which demand to place first, and which second, which to recognize, which to ignore. He must also decide what is meant by "the greatest good to the greatest number", that sentence as used by a famous Secretary of Agriculture in speaking of what is expected of the National Forests and the federal foresters. To meet and solve these problems requires much of a Job, and more of a Solomon!

I trust that I have brought out some of the functions of a forest and of a National Forest, in what has been said. How do these functions fit into the economic life of a State? To be specific, how do they fit into the economic life of a State like Washington?

Here I shall have to quote some figures—but surely scientists will not object to figures, so long as they are also facts.

Within its borders the State of Washington has 10 National Forests with a gross area of 11,350,000 acres; of this 1,700,000 acres are privately owned (by lumber companies, private individuals, railroad grants, etc.) leaving 9,650,000 acres of government land, or approximately one-fifth of the State's total land area. These Forests lie along the higher portions of the Cascade Range, from the Canadian border south to the Columbia River, one in the Olympic Peninsula, one in the southeastern corner of the State, and two here in the northeastern portion of the State (the Kaniksu and the Colville). The National Forest acreage bulks large, but it carries a stand of 77,927,-842,000 board feet, while privately-owned timber lands of the State carry 173,300,000,000 board feet. The more valuable and more accessible are thus privately owned; the government forests include over seven million acres of bare land above timber line, high or rough and rocky areas containing scrubby, non-merchantable timber stands, brush lands and glaciers. There are only some 2,460,000 acres of what might be classified as present-day merchantable, accessible forests, within the National Forests of the State. Primarily on these 2¼ million acres must successive tree crops be grown as the government's share in timber growing within the State. The high altitude forests, the scrubby timberline growth, are by no means valueless; but the reverse. They are primarily protection forests, for in them or in glaciers above them and flowing through them, are the headwaters of all of the State's great streams, of high economic value today, and of far greater potential value. There also, in these high altitude forests, these protection forests, are the summer grazing grounds for many cattle and sheep, and here also will be the great recreation grounds of the State, IF—and I spell it with capitals,—the forester can succeed in harmonizing the sheep, cattle, the camper, and the nature lover. They *have* done this in Europe. The Swiss people can not be accused justly of any lack of appreciation of natural beauty, of scenery, of wild life and wild plants, but the Swiss is too thrifty a soul not to pasture his sheep, and even his goats—on alpine pastures, and mountain sides splashed with nature's vivid colorings. And we Americans when viewing the Alpine shepherd, as he leans on his

crook, surrounded by his sheep or goats, somehow see the picturesqueness of the scene! We see this picturesqueness—and pay good money to see it. But here in our Washington Alps, too often is it the case that our camper's nose only, seems to function, and he will probably claim that his mountain view is totally spoiled by the smell of a sheep!

But to get back to our more prosaic figures and facts. What part are the National Forests of Washington playing today in the economic life of the State? What contribution do they make, in money returns and in public service? What future contributions can they be expected to make toward upbuilding and developing the State of Washington?

These are the principal contributions of the National Forests of the State:

1. TIMBER—Protection of their timber stands and management of them on a sustained-yield basis, in order to be able to make a permanent and continuous contribution to the country's timber supply and the State's timber industry, as well as to the individual communities and cities dependent on logging, lumbering or pulp plants. Here are distinct public benefits to a State whose whole past has been founded on its forest wealth, and whose future would seem to be.

2. WATER—Protection of the headwaters of the State's streams which supply cities and towns, irrigation projects and power plants with the necessary steady flow of water. Here is a service of immense value hardly calculable in dollars and cents.

3. FORAGE—Regulation and proper use of the forest grazing lands by sheep and cattle, to utilize the annual forage crops (otherwise wasted and if unused an actual fire risk), and in utilizing these resources to produce human necessities such as meat, wool and leather. Proper and wise use of these forage resources can be made and not interfere with timber production, stream-flow, recreation, or game. The National Forests of Washington annually supply summer range to 162,000 sheep and 11,000 cattle; the livestock industry is an important one in the State.

4. RECREATION—The National Forests of Washington last year were used by an estimated total of 1¼ million people, for touring, sight-seeing, camping, hiking, mountain climbing, hunting and fishing,—all health-contributions to the people of the State as well as to many outside visitors. The opening up of the Forests by roads and trails, the construction of summer resorts and summer homes, are making the high forested regions accessible to millions. Here is a large contribution to public health, to healthful enjoyment, to right living. This service cannot be valued in mere dollars.

5. FREE TIMBER—No inconsiderable item is that for free timber or timber sold at cost to settlers and ranchers for ranch or home development in or near the National Forests.

6. WILD LIFE—The National Forests are the principal breeding grounds and refuges for wild life. Washington is particularly rich in its variety and number of wild life. The Forest Service cooperates closely with State and County game officials in protecting and increasing the supply of game and wild life. All forest rangers are deputy state game wardens. Here is an attraction to outdoor lovers of all ages, castes or creeds.

All of the above public service contributions are rendered by the National Forests at no cost to the State. In addition, there is a direct cash contribution, for the counties in which the Forests lie receive annually 25 per cent of the gross receipts from timber sales, grazing fees, water power rentals, and resort and summer homes permits. This must be used for roads and schools. And here it may

be asked "What other industry or agency pays 25 per cent of its gross receipts to the State?" None.

From 1905 when the National Forests were turned over to the Forest Service to manage, to 1927 (fiscal year 1906-1927, inclusive), the federal government has expended in the State of Washington on and on account of the National Forests, a total of $14,198,-901.77. This has gone for roads, trails, protection against fire, fighting fires, administration, research and permanent improvements, such as lookout towers and houses, cabins, fences, etc.

From the 25 per cent gross forest receipts, the Federal Government has paid back to the State and counties concerned, a total of $1,143,178.64 which is a direct cash contribution, in addition to the several public service contributions mentioned previously.

For this same 22-year period, from 1906-1927, the total federal receipts from all Washington National Forests has been $4,598,637.00. In short the Federal Government has expended in the State of Washington over 10½ million dollars in excess of receipts from the National Forests in 22 years.

The National Forests of the State are valuable properties. They are worth protecting and improving as a business proposition. They serve in many indirect ways, on which it is impossible to place a money value; they also bring in a direct cash return to the State. Both of these returns will increase to the State and to the people of the State as these resources are developed and improved. They will continue to aid the State in its economic life, in making its basic industry—lumbering—a permanent one; in utilization of its great water powers; furnishing recreation for millions; they will help keep "Washington—the Evergreen State."

SERVICE AND OBLIGATION

Whatever the character of the work, every service carries with it an equal responsibility and the measure of success of an enterprise depends upon these two factors. In the service rendered by and to the members of the Northwest Scientific Association, the preparation of a program, its successful occurrence, the gathering of the papers and addresses, transmission through proper channels to the printer, correction of proof, return to the editor, his checking, and rechecking by the other members of the editorial staff, ultimate correction by the compositor, the make-up, printing and circulation of Northwest Science to subscribers, there is a joint service and obligation of many persons which involves both time and care. The failure of one unit in the operation is a source of inconvenience and additional labor to the other units involved,—sometimes worse. Every person engaged in this operation is given the responsibility as a compliment, from the official and author to the final issue of the publication, and an equal measure of acknowledgement must be made to insure the desired and proper measure of success. It is expected that the burdens will be unequal, they always are, but it is also properly anticipated that the several responsibilities will be discharged whether they be of time, character, or mass. This is not a complaint but rather a reminder, as it is an assurance, that each individual is expected to do his part, both promptly and well. There need be no worry as to results which will follow such a train of accomplishment.

WHY THE STUDY OF SOILS IS NOW A DISTINCT SCIENCE*

By W. L. Powers

Oregon State College Experiment Station

A modern concept of a mature soil is to regard it as a natural dynamic body with definite characteristics developed under the influence of climatic and related biological activities. Soils may be regarded as having youth, maturity, or age. A youthful soil will have a fleshy colloidal covering and a skeleton of mineral particles. With maturity it loses the characteristics of the parent material and acquires those imparted by the finer weathered particles, which vary according to the climatic zone under which developed. We are largely indebted to Glinka (1) and others of the Russian school of soil science for laying the basis of a natural, logical classification of soils of the world into climatic groups, and of establishing the study of soils as a science all its own. Modern soil science or pedology is a study of the genesis, morphology, classification, momenclature and utilization of soils. Mature soils are designated by Glinka as endodynamorphic to distinguish them from the etcodynamorphic soils, in which external factors largely determine the characteristics of the soil body.

Soil science is essentially different from geology, just as soils are distinctly different from common rocks of the earth's crust, for the following reasons:

1. Soils are more regularly distributed over the earth's surface than other rock. The same soil group may cover several kinds of rocks and soil materials.

2. Soils have characteristic colloidal constituents capable of the phenomena of base absorption and exchange. The weathered colloidal clay particles of soil are essentially, iron, aluminum, silicates and possess slight negative charges of electricity causing cations of bases to be absorbed and loosely held.

3. Soils have a characteristic layered arrangement of horizons in their profiles, varying according to the climatic zones under which developed.

4. Soils have a very close association with biological life of the earth.

5. The methods by which soil characteristics are investigated are necessarily different from those of pure chemistry or geology.

The soil profile includes all that may be seen in a fresh vertical cut through the soil and into the underlying soil material. Various horizons appear in the mature profile. The surface layer, under humid climate, being usually leached, may be designated the "A" horizon or "elluvial" layer, while the zone of accumulation or "B" horizon is referred to as the "illuvial" layer. Field study may be made to include the structure profile, texture profile, color profile, reaction profile, and profile of distribution of organic matter. Laboratory determinations will serve to check quantitatively and to explain field observations, yet the soil characteristics and soil classifications should be based upon the characteristics of the soil itself and not upon the forces or conditions producing them.

Proof of the relation of soil characteristics to climate is afforded in the great soil zones of Russia and the world.

1. The black earth soils or so-called tschernosem occupies an area having similar moisture conditions as determined by precipitation and temperature.

2. The fat-tschernosem is in the central part of this broad northeast-south-

*Presented at the Fifth Annual Meeting of Northwest Scientific Association, Spokane. Wash., December 27-28, 1928.

1. Glinka, K. D.—The Great Soil Groups of the World and Their Development. Edwards Bros. Trans. by Marbut. 1927.

west region and has the maximum of organic matter.

3. Individual humus zones follow this same general direction.

4. Vegetation tends to change with disappearance of this soil.

5. Tschernosem occurs over a variety of kinds of country rocks in the region of its distribution, such as loess, Jurassic clay, granite and Devonian limestone.

6. Similar soils are found in various continental areas throughout the world, having similar climatic conditions. The parkland of Saskatchewan and the dark pedocalic soils extending from northwest Minnesota to Corpus Cristi, Texas, are of this kind. In South America, black earth occurs in Argentine under similar climate as in the black earth region of European Russia.

The development of the gray ashy or podsol soil may serve to illustrate the processes that give expression to the characteristics of soil as a natural body. Such soil develops under cool, moist conditions, such as occur in northern Europe and along the northern boundary of the United States from the Great Lakes to the Atlantic. These soils develop under pine forests and have been studied and described by Wityn (2) in Latvia. He reports soils derived fom calcareous soil material which in humid regions results in the young soil with a deep humus layer. As the calcium carbonate is leached from the surface, the physical properties of the soil alter and deteriorate. When the lime content of the surface horizon is reduced, then the humus layer may become shallower from below and the light gray ashy layer is formed. Iron and aluminum are also leached out and the iron precipitated in the sub-soil that is still neutral in reaction giving rise to an impervious hardpan, with slow percolation and swampy conditions. The gray layer remaining from the leaching of the acid solution from the pine forest litter is high in silica. The humus is leached out, but may accumulate to some extent by precipitation in the substratum.

A very different example with which geologists are perhaps more familiar is that of the development of laterite under humid tropical forests in which the silica is dissolved out and the iron and aluminum residues remain with the development of pellets and even iron crusts. Where the end products of weathering are high in iron and aluminum as in lateritic soil, Bennett (3) finds a soil to be friable, absorptive of moisture, capable of being worked when wet, and resistant to erosive forces.

Soil maturity and even degeneration may follow the development of high acidity or high alkalinity, a sodium-clay or an acid-clay being liable to degenerate into its constituent oxides and the soil to lose its base adsorbing capacity. Liming may be fundamental to conserve the productiveness of the soil and to prevent marked differentiation of the soil body into elluvial and illuvial horizons of widely contrasting properties, abnormal in character and subnormal in productiveness.

2. Wityn, J.—A Brief Survey of Soil Investigations in Latyia. Bur. of Land Valuation, Riga, 1927.

3. Bennett, H. H.—Some Comparisons of the Properties of Humid, Tropical and Humid Temperate American Soils with Special Reference to Indicated Relations between Chemical Composition and Physical Properties. S/S. Sec. 21:349, 1926.

Spectrographic analyses made by Dr. Jacob Papish, Cornell University, show the presence of Germanium in many cassiterite samples. It has also been discovered in iron slags.

Northwest Scientific Association has added a large number of new members to its roll. The increase during the past year was about 30 per cent.

EFFICIENCY SURVEY OF FRUIT COLD STORAGE PLANTS IN CENTRAL WASHINGTON*

By H. J. Dana

Research Engineer, State College of Washington

In addition to the usual types of engineering research carried on at the State College it has come within the scope of the Engineering Experiment Station to conduct efficiency surveys of certain industries. In 1927, the writer was detailed to make such a survey of some 23 apple-packing plants in Central Washington. In 1928 surveys were made of some 21 cold storage plants in the same section. These surveys were undertaken at the earnest solicitation of representative members of the fruit industry.

Fruit storage plants in Washington commence operations with cherries, peaches, apricots, and pears in July and August. Apple storage begins in September and continues successively with various varieties until March and April. About 2½ months in the spring and early summer constitute the idle period.

The customary size of a cold storage plant is 50x100 or 100x100 with basement and two floors, giving a storage capacity of 50,000 to 100,000 packed boxes of apples. The storage revenue is approximately 20c per box for a season's storage. The electric power bill of such a plant will range from $200 to $600 per month—depending upon the temperatures of the outside air.

The use of cold storage for fruit in the Pacific Northwest is comparatively new having come into more or less general use only within the last 5 to 8 years Today, however, many of the present plants are being enlarged and new ones are being built throughout the fruit section of the state. Owing to the fact that fruit storage is comparatively new, there still exists a vast difference of opinion as to what constitutes a good design. Consequently there are varying degrees of operating efficiency to be found in different plants.

It was our mission to survey certain of these plants which seemed to be operating under difficulty and to point out wherein they could be improved. For instance, one plant was found to be using an early type of multivane fan, which by our tests was shown to be using three times the power to move the air being used as would be required by a modern type of fan. The excess power bill for this fan would pay for a new fan in one year. The following condition was found in another instance: The plant as it was originally built and equipped was 50x200 feet and two stories high. Later another unit 50x100 feet was added, and the fan was speeded up to handle the additional air needed for the new unit. Permit me to digress for a moment to mention the fact that a certain amount of air may be moved by a proper size modern efficient fan operated at slow speed and requiring a minimum of power. The same air may be moved by a smaller fan operating at high speed and requiring as much as twice the power. In the second instance, there results not only an excessive power bill, but this extra power is absorbed in the heating by churning of the refrigerated air, which in turn has cost money to be refrigerated. In the instance cited above, the fan, which was of modern and efficient type, was being operated considerably above the maker's recommended speed for any kind of service at the static pressure of the system. And yet, the installation was made at the direction of a self-styled refrigeration expert. The proper size fan for this job will pay for itself in two years' time in saved power bills, and will

*Presented at the Fifth Annual Meeting of the Northwest Scientific Association, Spokane, Wash., December 27-28, 1928.

make available to the storage rooms some 2½ more tons of refrigerating capacity. It will be recognized that a given amount of heat may be carried away from stored fruit by means of a small amount of very cold air, or by a much larger amount of warmer air. However, the process of refrigerating the air will result in extracting more moisture from the colder air with the result that it will be drier and will take up more moisture from the fruit thus causing excessive shrinkage. An instance was found where one plant was using 27,000 C. F. M. where the circumstances called for some 55,000 to 60,000 C. F. M. As a result, the air coming to the storage rooms was around 24 to 26 degrees F. resulting in frequent frosting of the fruit near the cold air ports.

Another instance was found in which adequate distribution of the refrigerated air was not made throughout the storage rooms. As a consequence, temperatures varied as much as 8 and 9 degrees between different parts of the same room. When it is considered that the desirable storage temperature for apples is 31 to 32 degrees F., it will be seen that the above condition was intolerable. And yet, when this plant was built some six or eight years ago, it was considered to be well designed—at least by the man who designed it. At the time these plants were built, most of them included the very latest ideas for efficiency. However, the advance in efficient design is making it economically necessary for many of the owners to re-vamp their old plants.

It is customary in fruit storage rooms to bring the cold air to the room and distribute it through a set of ducts to different points of the room. Other ducts take the warm air back to be refrigerated again. The cold air ports are often located near the walls of the room, and the warm air ports through the center of the room. This results in cooler fruit near the cold air ports than in the center of the room near the warm air ports. To overcome this, some plants are equipped to reverse the direction of flow of air through the rooms periodically. This is accomplished by reversing the flow of air through the fan, which is of the propeller type, by reversing its direction of rotation. To begin with the propeller type fan is not nearly as efficient as the multiblade type at the static pressure found in cold storage plants. Furthermore, these fans are only approximately one-half as efficient in reverse as when operated forward. As a result, they deliver only about one-half as much air to the plant in reverse as when operated forward and consequently difficulty is experienced in maintaining the room temperatures during the reverse part of the cycle. And yet, the owners, being cognizant of the results, had not placed their fingers on the seat of the trouble. We find the solution to the above, to be easily accomplished through the use of an efficient multivane type fan and a simple system of cross ducts and dampers, costing less even to install than the present-used system, and certainly costing less to operate—to say nothing of improved refrigerating service to be gained.

A number of such instances could be cited where incorrect type or size of equipment, or incorrect method of operation were yielding results not up to present standards of refrigerating practice. However, the above will serve to illustrate one of the several types of service which the Engineering Experiment Station of the State College is equipped to render to the citizens and to the industries of the State of Washington.

Notice of Change of Address: Members are requested to notify the Secretary of change of address promptly and particularly at this time in order that it may be properly entered in the list about to be published.

TEMPERATURE AND SEED GERMINATION. AN ABSTRACT*

By Ferdinand W. Haasis

School of Forestry, University of Idaho

This is a brief report of the results obtained in some studies made at the Laboratory of Plant Physiology of the Johns Hopkins University in the year 1927-1928. Part of these results are treated more in detail in a paper (Germinative Energy of Lots of Coniferous—Tree Seed, as related to Incubation Temperature and to duration of Incubation), published in "Plant Physiology", December, 1928; Vol. 3, No. 4, pp. 367-412.

The object of these experiments was the ascertaining of the influence of maintained temperatures, acting for various lengths of time, upon the germinative energy of lots of seed of several different species, the percentage of germination occuring under the test conditions being considered as the index of germinative energy. For most of the tests pitch pine seeds were used.

The seeds were incubated (after an hour's soaking in a disinfectant solution of "Semesan") on agar plates in covered glass petri dishes, 100 seeds constituting a standard culture. Incubation occurred in a battery of seven controlled-temperature chambers, 36 different temperatures being employed, ranging from 8° to 57° C.

For the main lot of pitch pine seed used it was found that germination occurred (in 6 hours after planting) even at the highest temperature employed, 57°. The maximal temperature for the occurrence of germination in this lot of seed, therefore, was apparently around 60°C. (140° F.)

The minimal temperature for the occurrence of germination ranged from 44° for the six-hour period to less than 15° for the 14-day period.

The optional temperature for the occurrence of germination in this lot of seed disclosed some very interesting relations. For the 6-hour period it was about 46° C.; (115° F.) for the 2-day period between 42° and 46°, but with a secondary optimum about 32°-33° (around 90° F.); for the 3-day period the primary optimum was at the lower temperature, the high-temperature optimum having become secondary. For the 5-day and longer periods the low-temperature optimum was the only one. It is obvious that under certain test conditions this double optimum might not have been evident.

This double optimum was not due to the antiseptic treatment. The seedlings which were produced at the higher temperatures were unhealthy. Possibly this is attributable to oxygen deficiency; and studies on this phase of the problem are now in progress at John Hopkins.

In less extensive tests with two other lots of pitch pine seeds, the phenomenon of a double optimum was observed but for yet two other lots it was not evident. It was observed in tests with seeds of red pine, lodgepole pine, long-leaf pine, loblolly pine and Engelmann spruce, but not for western yellow pine nor white spruce. In fairly extensive studies with one lot of rice seed, also, this phenomenon was not observed.

There appears to be no doubt that the double optimal temperature observed for the occurrence of germination in one lot of pitch pine seed is to be expected not only for other lots of seed of that species but also for seed of five other coniferous species. Since this phenomenon has been observed for some lots of seed and not for others, it is obvious that failure to observe it does not indicate that other lots of seed of any given species cannot exhibit it.

*Of a paper delivered before the Forestry Section. Northwest Scientific Association, Spokane, Wash., Dec. 27, 1928.

OVERWEIGHT IN RELATION TO LIFE EXPECTANCY*

C. M. DOLAND
Physician, Spokane, Washington

Today all the records and all the information on which a scientific and sound selection of lives can be made, is accessible to every sound and serious and properly conducted life insurance company. Science is doing its work and the old order is passing. The old day of selecting risks by the whim of the Medical Director and accepting or not accepting him according to whether the Doctor's breakfast was agreeing with him and a lot of other things of that sort, is passing. As a matter of fact more than 60% of the business of one of the largest companies in America according to its President never goes before a doctor at all. The risk is selected on the facts as they are. It is not a matter of guess or opinion. It is action based upon statistics.

In the old days, prior to 1904, many companies were still selecting overweights more or less liberally on the remnants of the old theory that they might expect as good or better mortality from overweights than underweights. The Medical Actuarial Investigation and their subsequent experience have taught them, however, that the opposite is the actual condition.

The Medical director of the company that made one of the first thorough analysis of their experience with overweights said; "I think that there is only one conclusion to be drawn from these facts, and that is that any Company that accepts risks on lives 25% or more overweight, is going to have a high mortality among those lives."

In reading through the tables of the experience, we find raitos of deaths of overweight running from 115 to 254% of the expected mortality for the ages at which the policies were issued. We will not take the time to review a formidable mass of statistics but the epitome is that today overweight is as potent a cause for rejection as organic disease.

Since 1907 there has been a very marked improvement in the general mortality of the community. We have also the effect of a vast amount of propaganda, started largely, we believe, by the insurance companies, against overweights. It has been in the public press, it has been devised into the ears of the unhappy overweight by his friends, and people have learned that they have difficulty in obtaining insurance if they are overweight. Added to this is the general interest in diet, calories, etc.; as well as education as to the necessity of a moderate amount of exercise; all of which have had their effect on the overweight or "near" overweight.

The principal cause of death giving the rate per 100,000 as compared with the general experience show a higher rate in cancer, in diabetes at the older ages, in all the degenerative diseases, in diseases of the liver and gall bladder.

How are the life insurance companies meeting this question? Most of them make a distinction between *big* men and *fat* men. They try to find out whether the fat a man has consists of a normal, thin, firm cushion of fat equally distributed over his body or thick layers of fat or flabby rolls of fat, a big abdomen and so forth.

A big man with a big body and short legs, especially when that physique is a family characteristic, is given more consideration. A good family record with overweight as a family characteristic, is definitely favorable; a good family record with overweight not a characteristic helps somewhat, while a poor family record is a definitely bad impairment in overweights. To quote one medical director he selects "the draught horse type rather than the race horse type overlaid with adipose."

*Delivered before General Session, Fifth Annual Meeting of the Northwest Scientific Association, Spokane, Wash., Dec. 28, 1928.

TEACHING CHEMISTRY IN HIGH SCHOOLS*

G. F. CLUKEY

Head Dept. Chemistry, Lewis & Clark High School, Spokane, Wash.

The purpose of this paper is to set forth the methods of teaching chemistry at The Lewis and Clark High School in Spokane.

The department consists of two well equipped laboratories, a balance room with six balances of the Troemmer type, and one Saratorius balance; a dispensary and a recitation room all en suite. The recitation room is furnished with ampitheater seats, a mineral cabinet and a teachers demonstration desk which is provided with direct and alternating current, gas, compressed air and hot and cold water.

There are three teachers each having four classes to which our three hundred students are about evenly assigned. To pupils enrolled in the scientific course we give one year general chemistry; and to girls taking Home Economics, we teach one year of Houshold Chemistry. About one hundred girls are taking this latter course.

In the department the following facts are recognized and thoroughly understood: that the first requisite of successful teaching of chemistry is the presence of a wise and skillful chemistry teacher. That a method of teaching chemistry is but an orderly mechanism; that its efficiency depends on what the teacher puts into it; that the teacher must come before his class each day with a thorough and fresh knowledge of the subject matter of the lesson. He must have the subject in mind not in a dim shadowy outline, but in bold relief with every essential fact and principle clear and distinct. His knowledge must not only be systematic but also *fresh*—the result of recent study. Every power and every energy of the teacher is required to search through the minds of his pupils to test the results of their studies. The instructor before his class has no real time to recall the half-forgotten results of past study. If the teacher does not know what is in the lesson, he may be certain that his pupils will not.

In the laboratory the student writes his notes as he does the experiment. We use an interlinear manual, and as soon as he finishes he brings his notes to the instructor for approval and questioning and for help on obscure points. The teacher helps him by aiding him to help himself; recognizing that the function of the teacher is to lead the student to self reliance. This he does by referring the pupil to past experiments, to his text book, or at times by having him repeat a part of the experiment. If the pupil evinces unusual interest, he is referred to books more advanced and of different style.

In recitation, the teacher aims to obtain topical recitations requiring the pupil to use the technical language of the subject. He requires the pupil to show by his recitation that he has mastered new words and can pronounce them. If he can not, he is sent to the Standard dictionary kept in the room. This is not to punish him nor merely for him to learn to pronounce and define that particular word, but to convince him that he must master the pronunciation and meaning of new words before the recitation hour. He is required to show that he has assimilated the ideas set forth, and can tell them in passably constructed sentences. The pupil is taught to stick to his topic and thus develop habits of logical thought. The teacher does little explaining, realizing that he is of value just in proportion that he does not talk but does get his pupils to talk.

*Presented at the Fifth Annual Meeting, Northwest Scientific Association, Spokane, Wash., Dec. 27-28, 1928.

The teacher avoids the asking of general vague questions, for example, "What about the cost of food?" but makes his questions clear for example, "will you please develop the topic, 'The cost of food as related to its nutritive value?' " moreover, he asks the question before naming the pupil chosen to recite. The pupil is allowed to recite without interruption of any sort, and at the end of his recitation an individual pupil is called upon for criticism and correction or for omissions. These criticisms must always be kindly and courteous aiming at helpfulness.

Another fact recognized is that interest is conditioned upon knowledge. The pupil is required to learn his lessons thoroughly from the beginning. The beginning simple work must be dwelt upon by the teacher by demonstration in the recitation room, by review, by trips to industrial plants and by written tests. Thus as weeks go past the rising tide of interest in the new subject is kept at flood avoiding the deadly ebb in the middle of the semester. This ebb in interest which occurs about the middle of the term and results in a plateau of accomplishment is obviated. Instead, as curiosity concerning the new wanes, the class finds itself interested in the new lesson because of its relation to the old. And this relation to the old is clearly perceived because the pupils have thoroughly learned and understood as far as they have gone. The work that one has done on a thing is a reason for his interest in it. The parts of our knowledge or our wealth most intimately ours are those which are saturated with our labor, and a student doesn't allow his interest to lag because he has spent so much time and labor on the course in the past.

In demonstrating, the teacher uses apparatus like that pictured in the text. He does not explain his demonstration, but tells what the class may expect to take place, leaving the explanation to individuals called upon to interpret. It is wise for the demonstrator to announce the results that are to be expected; otherwise the observer may not get the salient thing, because his interest may be caught and held on phenomena not pertinent to the particular lesson to be learned. Whether the topic illustrated by the demonstration should be recited before or after the demonstration, is a mooted question. My personal belief is that the recitation should come before.

Conversation during laboratory periods is not permitted; and the teacher is circumspect as to assemblage of apparatus, cleanliness of bottles, shelves and balances. Although schooling is free, pupils are required to replace apparatus destroyed. This is done by the coupon system. The coupon system is merely to teach boys and girls care of property. Any amount of the deposit remaining is refunded at the end of the year.

A deep and abiding respect for the subject is created by visits to manufacturing plants; for there the learner is given opportunity to observe practical uses of the science, to see chemistry at work. Moreover he sees that modern industry would be impossible without the aid of the specially trained, technical chemist. Classses are not, on these trips, required to take notes nor to report on what they saw. However, time is taken during the next recitation period for a discussion, and for entering credits for the trip.

Much time is given to helping pupils before and after school hours, so that the number falling in arrears with their work and therefore dropping the course is very small.

It is the commonplace in chemistry teaching that really counts. There is no royal road to the learning of chemistry, and the pupils come to the acceptance of this fact. They are satisfied that they are growing in power and when they have finished the course, they know they have had something worth while.

Pneumonia Yields to Science*

Pneumonia is a disease occurring in all types of people, but especially in early adult life. The germ known as the pneumococcus finds favorable reception in bodies whose resistance is lowered by exposure, dampness, or any of the results of careless living. Since 10 per cent of all deaths in the country are the result of pneumonia at the present time, it is worth while for every individual to give the matter some thought, to use the simple precautions and wise personal habits which will give the largest measure of protection.

Avoid exposure to drafts. Avoid unnecessary sweating, followed by exposure. Keep your feet dry. Keep your house at a normal temperature, not too warm, with moisture in the air. Sleep with open windows, and sleep long enough to throw off fatigue and rebuild health tissues.

Pneumonia is a contagious disease, and should be treated as such. Crowds spread contagions—protect yourself and your family by avoiding crowded. overheated places.

Beginning usually with sudden chills, fever, a short sharp cough, rapid and difficult breathing, there is ample warning of danger ahead. Take no chances. The theory that "This is just a cold, I'll throw it off" has had too many fatal terminations. Call your own family physician, and give yourself a fair chance.

The habit of regular physical examinations will keep you informed, will help you avoid lowered vitality and give you warning of any little creeping danger. Remember—

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*Sponsored by Members of the Spokane, Coeur d'Alene and Lincoln County Medical Associations.

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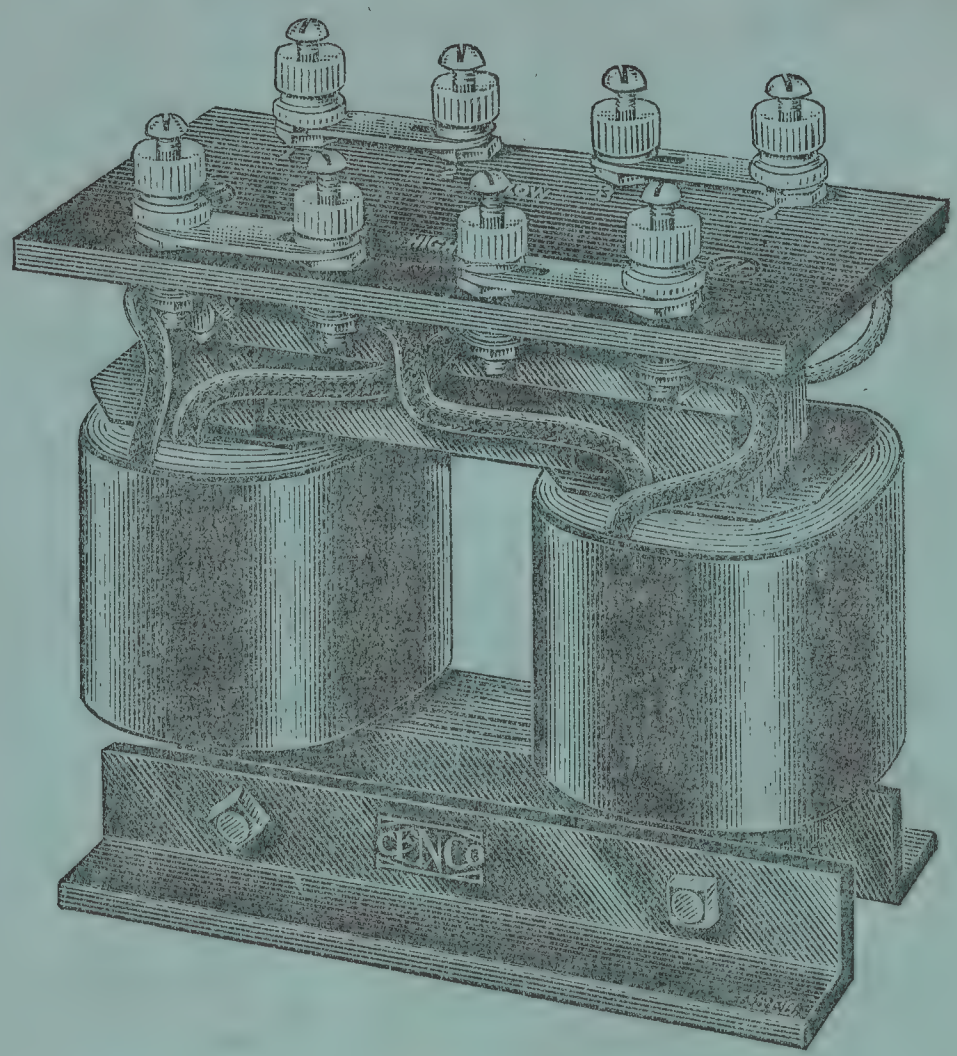

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NORTHWEST SCIENCE

VOL. III JUNE, 1929 NO. 2

ZONING: A PHASE OF CITY PLANNING*

H. F. AUMACK

Engineer for City Plan Commission, Spokane, Wash.

There is a more or less widespread impression that zoning and city planning are separate and distinct sciences; this however is not the case. Zoning is a branch of city planning and is perhaps its most important phase. City planning deals with a number of the problems of a growing city; in fact many of these problems are a result of such growth and expansion. A comprehensive city plan directs the city's growth in an orderly and systematic manner. No sane person would attempt building a single large building without a carefully drawn plan and a complete set of specifications, yet in the past vast numbers of buildings both large and small, costing many millions of dollars, have been erected; likewise enormous sums have been spent building roads and highways that are soon to need widening, and parks have been located and developed at great expense by cities having no plan covering the development of the community as a whole.

Wide awake progressive cities have been quick to grasp the value of city planning and from a mere handful in the United States in 1916, active plan commissions have reached the number of four hundred nine by the end of 1927, with one hundred eighty-one of them having completed comprehensive plans and most of the balance preparing them. Zoning has likewise advanced rapidly from a single city in 1914 to five hundred sixty-nine by the end of 1927 which have zoning ordinances in operation.

City planning deals with all the problems related to growth and expansion of the city, while zoning as a branch of planning, classifies the various uses of property, assigns each use to appropriate districts and in addition may provide regulations governing the height and area of buildings. Zoning has a definite place in a complete city plan and is inseparably allied with its other phases, namely: major street plans, transit problems (passenger transportation within the city), rail and water transportation, public recreation and civic art which includes architectural treatment of public buildings.

Zoning does not come first in the natural sequence in preparing a city plan, but very often it is the first phase to be actually undertaken. The reason for this is simple and easily explained. Since from seventy-five to eighty-five per cent of all the buildings in the average city are single-family residences, the intrusion of undesirable uses such as stores, garages, small factories and other commercial uses into the residential districts creates a desire for regulation in such cases, that is almost universal. The people in demanding such regulation learn that zoning is the name applied to the machinery of the law that can best be applied to remedy the undesirable condition. Hence, a demand for zoning from the interested public is forthcoming. In fact, the people usually demand zoning regulations before they know the meaning of the term. Every protest against a store or service station locating in a residential district is a demand for zoning. As previously stated, zoning is usually undertaken before any other phase of the comprehensive plan, though its logical place is near the last

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in planning activities. This is not at all serious as to results, because the related branches of city planning are so essential to zoning that no competent planning engineer would attempt zoning without first investigating them to the extent necessary to make his zone plan fit existing conditions and most of the possible future developments. For example, the development of a residential district depends not only upon the uses permitted in the district but upon the means of access to the district from other portions of the city (major traffic streets together with transportation facilities provided by public service corporations such as street cars and busses) and proximity of public recreation facilities (parks and playgrounds). Likewise the location and development of commercial districts are seriously affected by transit and traffic conditions. A study of the transportation facilities, both rail and highway, cannot be omitted in the classification of districts for industrial uses.

Zoning may be properly compared to the so called "building restrictions" or "deed restrictions" placed in deeds, restricting the use to which land conveyed by deeds may be put. These deed restrictions are in fact "private zoning." Zoning provides a place for every legitimate use of property and in addition provides the legal machinery for keeping these uses in the places set aside for them, which is something that deed restrictions cannot do.

The old-fashioned building restrictions are very good in their limited way but the limitations are undoubtedly a serious handicap. Being by nature a private contract and not an ordinance or law on the statute books, these restrictions can only be enforced by recourse to the civil courts and this involves the employment of counsel and expense to those interested in seeing the restriction enforced. The zone ordinance, like all other ordinances, is enforced by the municipal officers at no special cost to the district involved. It provides that violations of the ordinance are misdemeanors and violators are punishable by law.

In some states deed restrictions are wiped out by a tax foreclosure; this often leaves a few lots located in good residential districts open for development in any manner the purchaser of the foreclosed lot desires. A number of undesirable commercial uses have worked their way into the best residential districts in the City of Spokane through the medium of tax titles. One other undesirable feature of deed restrictions is the fact that they are not flexible and cannot be amended. In order to be of real value, a zoning ordinance must be flexible that it may meet changing conditions; by flexible I do not mean weak or easily bent to every man's whims, but that appropriate means, clearly stated, must be provided for the reclassification of districts or amending the ordinance proper to meet changing conditions which are certain to develop.

Let us consider briefly the method involved in drawing up a comprehensive zoning ordinance and in dividing a city into the districts provided for by the ordinance.

First a careful survey of existing conditions is essential. This includes major traffic or arterial streets, location of street car and buss lines, trucking highways, rail and water transportation, topography and also the location of the various kinds of existing uses. Possible and probable direction of future expansion must also be kept in mind. In order to draw up the ordinance intelligently, industrial uses peculiar to the city must be carefully classified. Ample space must be alloted to essential industry in such locations as are the least objectionable to residential developments and at the same time are adapted to the needs of industry.

Uses of property may be classified into three general types: residential, commercial and industrial. Each type may be subdivided into two or more minor

classifications; common practice is to divide each main type into two classes as follows:

RESIDENTIAL

(a) Single-family dwelling districts.
(b) All dwellings, including multiple dwellings such as hotels and apartments.

COMMERCIAL

(a) Local business districts for neighborhood stores.
(b) General business districts for all types of commercial uses such as retail stores and offices.

INDUSTRIAL

(a) Light industry and manufacturing district. (Non-obnoxious industry.)
(b) Heavy industry or unrestricted district. All legitimate uses are permitted.

Local conditions largely determine the number of zones or classifications. In some instances it is advisable to have three classes of residential districts and only one industrial; in others there may be three residential, three commercial and three industrial. Vancouver B. C. has ten zones in all, while Portland, Oregon has but four.

The question of segregating the many kinds of uses of property and assigning them to appropriate zones is another serious problem. Fortunately most of the uses can be assigned to one of the three major classes without much question. It is the classification of the various types of residential, commercial and industrial uses into subdivisions of each type that requires the most study. Here again local conditions play an important part in the work. Some uses are found which have certain features that recommend them for classification as commercial and still other features which are of a nature more or less objectionable in a commercial district but entirely in accord with the provisions governing the light industrial district. Conditions such as this can be disposed of by classifying the use as light industrial but permitting it in the commercial district by local option or consent of neighboring property.

After the uses are all classified and a working outline for an ordinance is prepared, the actual location of the districts or zones can be begun. This should not be attempted without a thorough knowledge of all the existing uses in the city as well as the topographical features. Existing uses wherever compatible with good practice should be zoned so as to conform with the provisions of the ordinance. In other words, districts which from a theoretical sense are ideally located, may fit existing conditions in such a manner as to be ludicrous. I am, of course, dealing with a city which has reached a mature size with no regulation as to the location of various uses. Traffic congestion in the modern cities is causing certain kinds of business uses to move out from the central business district into the residential districts. Small local business centers are necessary to care for this condition which is to be encouraged in order to keep unnecessary traffic from the central district. There has been a tendency in the past to zone too much property for business uses. A very comprehensive survey made in the East has shown that an average of fifty feet of business frontage is all that is actually in use per one hundred people. The classification of too much property for business uses tends to depreciate property values and to create unnecessarily a large amount of "border line" or "buffer zone" property; that is, residential property adjoining property of a less restrictive nature. It is best to classify conservatively and add new business zones as the conditions warrant them.

Limitation of the height of buildings as well as regulation of the area of buildings in regard to the size of the building site may be handled either through the zoning ordinance or through the building code. Much has been written and said both for and against the limiting of

building height. The subject has so many different aspects that time will not permit a detailed discussion in this paper. It is quite generally conceded that high buildings are undesirable for the following reasons: they offer serious obstruction to light and air both in the street proper and within the buildings; they cause traffic congestion and unduly crowd people into small areas causing unhealthful conditions; they offer serious handicaps to fire fighting and increase the cost of fire fighting both as to apparatus and high pressure water service; they tend to depreciate realty values upon neighboring property.

Desirable open spaces around buildings can be obtained in two ways. One is by limiting the size of a building to a certain per cent of the site to be occupied; the other is by requiring certain specified yards to be provided around every building. The area method is worked out so that in some cases the buildable area in high-class residential districts is limited to as little as thirty-five per cent of the lot area and ranging upwards to as much as seventy-five per cent or more for apartments and hotels. The yard provisions are better than the area provisions inasmuch as they limit the location of the building to a certain portion of the lot by requiring specific front, side and rear yards to be left open and unoccupied. The proposed ordinance for Spokane requires a front yard twenty feet in depth, a rear yard of twenty-five feet and side yards on each side of a building of five feet in width for all buildings in the Class I Residential Districts. This permits free circulation of air and prevents one building from cutting off the light or view of another.

In conclusion,I wish to quote from a pamphlet published by the City Plan Board of Boston, "What Zoning Does."

1. Zoning divides the city into districts, according to the most suitable and valuable uses of each district; based on existing conditions and future needs and regulates the location and use of new buildings.

2. Zoning makes provision for ample general business districts in suitable locations in which industrial plants may not impair the business environment.

3. Zoning places suitable land in industrial districts where the best of transportation facilities by rail, water and highway may be secured and factories may easily expand without tearing down expensive buildings.

4. Zoning provides unrestricted districts, suitable places for those heavy industries such as stockyards, boiler works, coke manufacture and other industries that would be objectionable elsewhere.

5. Zoning regulates the heights of buildings appropriate to their use, so as to provide an equitable distribution of light and air for all; minimizes overcrowding of people and relieves traffic congestion.

6. Zoning provides local business districts, conveniently located near residential neighborhoods, where stores will be concentrated instead of being scattered everywhere.

7. Zoning protects the comfort, convenience and quietness of residential districts by excluding stores, public garages launrdies, factories and other business and industrial uses.

8. Zoning establishes uniform building lines in residential districts to assure an equal amount of light and air and access for all residences.

9. Zoning provides adequate light and air by side and rear yards around every building in the suburban residential districts and establishes the percentage of area of a lot that may be occupied by buildings.

10. Zoning preserves the home character of single and multiple family residence districts by segregating types of residences into districts where they are appropriate.

As a sort of postscript I add this sum-

mary of zoning by the late Prof. George C. Whipple, authority on sanitary engineering:

"Zoning should be regarded as a sort of collective self-control, a means by which a city controls its own life and growth for the best good of all its citizens. It is an act of police power fully justified in the interest of morals, safety, and health."

STUDIES ON THE MODULUS OF ELASTICITY OF CONCRETE*

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During the last two years considerable work has been done in the Materials Testing Laboratory at the State College of Washington in studying the ingredients, the proportioning, and the physical properties of concrete.

It is not the purpose of this paper to present the large amount of data obtained during this period, or to go into detailed discussion of any one phase of the work, but to outline the nature of the work done and to give in general the present status of some of the findings.

The original problem or the reason for starting the study two years ago was:

First, to determine why the crushed basalt rock, which is common to the Columbia River Basin, does not give expected results when applying the calculation method of proportioning as outlined by the Portland Cement Association in their booklet, "Design and Control of Concrete Mixtures."

Second, to check the water-cement ratio curve for materials of the Inland Empire.

Since starting the study several new problems presented themselves, while the first problem has decreased in value, due to the fact that the Portland Cement Association has practically eliminated the calculation method of proportioning and now emphasizes the Trial method.

At the present time our study can be given the following phases: First, to study the Inland Empire sands, their suitability as a fine aggregate for the making of an economical concrete considering the cost of materials and placement. Second, to compare gravel and crushed basalt as a coarse aggregate. (This problem is of real importance in the building program of the State College and many Inland Empire towns due to the fact that the crushed basalt can be obtained locally while gravel has to be shipped from a distance.)

Third, to determine the modulus of elasticity of concrete. This study can be subdivided as follows: First, to determine the average value of the modulus of elasticity for various strengths of concrete. Second, to determine whether concrete is or is not truly elastic throughout any part of its total range of strength and, if so, has it a true elasticity limit like steel, Third, to study the change of the modulus of elasticity with age.

Fourth, to apply the data obtained for the modulus of elasticity to more accurate and economical design of reinforced concrete beams and to check the designs by locating the position of the neutral axis by experimental means during the loading of beams.

Fifth, to keep a record of all of the vital data in regard to the water-cement ratio used, the physical properties of the individual aggregate, the methods and values of proportioning, and the methods of testing with the results obtained, for all concrete made, whether in the construction of buildings on the State College Campus or in the laboratory.

From these data covering the making and testing of hundreds of test cylinders, certain generalizations can be made from time to time. As further data are obtain-

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ed, these can be substantiated or eliminated.

Due to the design and construction of a new type of compressometer in our laboratory (fully described in Bulletin No. 25 of the Engineering Experiment Station, State College of Washington) measurements of deformation can be made on ordinary concrete cylinders to a high degree of sensitivity and accuracy, even to record changes of length caused by load increments of seven or eight pounds per square inch, in which case the deformations are of the order of a millionth of an inch per inch of length.

This ability to read deformations to such a high degree of accuracy has brought out many interesting generalizations which have not been discovered with the less accurate instruments used in the past.

Briefly, some of the things thus far determined are as follows: First, the value of modulus of elasticity for any design strength is quite uniform and considerably higher than the value used in design. For example, concrete designed for 2300 pounds per square inch and 28 days old will show a secant modulus of elasticity at one-third of its ultimate strength of 3,630,000, which is the average of 29 cylinders taken from one Campus construction job. A value of 2,000,000 would be called for by the "code" in the design of the beams and floors of this job.

Second, concrete at an age of 28 days is elastic and does have a true elastic limit value, which as a rule occurs between one-fourth and one-third of its ultimate strength. This is contrary to results published up to the present time but is supported by results given by Dean A. N. Johnson of the University of Maryland, in the reports published in "Public Roads," October and November, 1928, issues.

The condition of elastic concrete may or may not be found as the concrete increases in age. We have not enough data for six months and one year or older to verify the 28 day condition.

Third, the value of E changes only slightly with age, the seven day value being very close to the 28 day value. A very limited number of tests indicates a slight falling off at six months in the value of E as compared to the 28 day value.

Other tentative conclusions could be drawn. However, because of lack of sufficient verification they will not be given until later.

Why should concrete be studied using such fine measurements, involving considerable time and expense? Concrete can be manufacured by almost anyone. Almost any kind of aggregate will "get by" on many jobs. Cement is a standardized product, and we expect the same results in its cementing qualities in Washington as in New York.

We look forward to the time when in its cementing qualities in Washington concrete can be used on our construction jobs with just as much certainity and uniformity as we use steel today. When that time comes we shall know that our construction has the least cost and each element has the expected strength.

In the design of concrete structures we use liberal factors which are liberal because test values in the past have either been erratic or undetermined. Consequently, many tests of beams in the laboratory as well as floor slab tests in buildings have shown strengths twice what we expected, or deflections at design loads less than one-half the computed values. It is to eliminate this great waste that our laboratory and many other laboratories throughout the country are studying concrete along lines not appreciated by many of the laymen.

U. S. Geological Survey Professional Paper, 154-H contains further information on the fossils of the Latah formation in the invirons of Spokane, as determined by Dr. E. W. Berry.

ASPECTS OF PRESENT MANUALS OF DICOTYLEDONOUS PLANTS*

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The manuals for the naming of plants, which are used in the high schools and universities, are rather confusing in some critical points to amateurs as well as to some who should know something about the work. As an illustration, ovary superior (hypogynous), ovary perigynous, and ovary inferior (epigynous) are perhaps the most pertinent.

This difficulty is partly brought about by the fact that our manuals do not separate families having superior ovaries and ovaries perigynous in the keys. As an example, Piper & Beattie have Rosaceae on one line, and the next line is Portulaceae. In the Rosaceae family we have perigynae, and in the Portulaceae family the ovary is superior, hypogynous. Again in the Geraniaceae the ovary is superior, and on the following line is the Saxifragaceae family which is perigynous.

Manuals should consider that if the petals, sepals, and stamens have their origin below the ovary that the ovary is superior, hypogynous; but as soon as you find that the origin of the stamens, petals, and sepals is on the edge of a disk, no difference how small the disk may be, that we have perigynae. Students have difficulties in being able to decide if the ovary is superior or if the stamens are perigynous. The disk may be grown fast to the ovary, but if it does not enclose the ovary, it is still a case of perigyny: this by most authors is termed ovary at least half inferior. This is illustrated by such families as Loasaceae, Cactaceae, Onagraceae, and by the genus Philadelphus in the Saxifragaceae family. The ovary is not inferior (epigynous) until the disk has grown fast to the ovary and completely encloses the ovary. A few families illustrating epigyny, i.e., ovary inferior, are Caprifoliaceae (honey sucle family), Valerianaceae, and Compositae (Asteraceae). Many other cases may be cited.

Manuals may be made more understandable and teachable if they separated the families having ovaries superior (hypogynous) from those which are perigynous or epigynous. This could easily be done by introducing two new super orders: the Axiflorae, those having the petals, sepals, and stamens fastened to a mere axis (end of peduncle) below the ovary; and Calyciflorae (cup or disk flowers), that is having the stamens, petals, and sepals fastened to the edge of a disk or cup. Should such a division be used, those flowers having their pistil or pistils on a torus or receptacle with the stamens, petals, and sepals fastened below the pistils would be considered as the nucleus from which these two lines, Calyciflora and Axiflora, have their origin.

This may have been brought about in the case of the Calyciflorae by the gradual expansion of the lower part of this receptacle into a disk and, therefore, its gradual reduction. In the case of the Axiflorae there seems to have been a gradual reduction and almost complete disappearance of the receptacle, to such an extent that it might be merely called axis. The pistil is attached only on its basal end, and the stamens and perianth are always attached below the pistil.

If this scheme could be incorporated into a manual, students could always depend on flowers in the super order Axiflorae as having the ovary superior. In the Calyciflorae students could depend on perigyny or epigyny. This form of a key would prevent many of the errors made by the students and amateurs and result in a greater interest in the flora of our country.

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WHAT IS RESEARCH?*

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I would like to say at the start that I realize how broad is the field covered by the question which is the title of this paper. It is not my intention to attempt answering in ten minutes the question of what is research in all its bearings. My aim will be more particularly to point out distinctions between research and closely related forms of scientific inquiry which are often confused with it.

Research is an impressive and much-used word in the present era of great scientific and industrial progress. It is also a very loosely used word, and unfortunately we scientific workers are often as much to blame for this as the layman and popularizer of science. In the field of forest research in this region, there is a special committee now seeking to define what is and what is not research, in order that those engaged in planning and administering forest-research programs may do so more intelligently and with a view to better co-ordination of regional efforts by the different forest agencies. This statement would seem at first thought to imply some obtuseness on the part of forest investigators as compared with workers in other fields of science. But this is not the case, if we are to judge by the general situation in scientific and industrial research, as reflected by the periodic literature on the subject. For example, we find no less a scientist than Professor Michael I. Pupin stating in Science: "I have had many discussions with my colleagues at Columbia University and in other places about this question: 'Is such and such experimental work a scientific research or is it not?'" He then adds that the answer is not very obvious and devotes most of his paper to giving examples of what is real research. Among the industrial research workers, we find Director C. F. Kettering of the General Motors Research Laboratories taking special pains to define research in what he calls its simplest terms. And we find still other scientists, like Dr. Carlton R. Ball and Professor Henry Shaler Williams, emphasizing the distinctions between true research and less intensive forms of scientific inquiry.

The situation among forest-research workers is probably chiefly due to a lack of definite understanding of what the term research implies. And this in turn may be due to the very loose popular use of the word as meaning any more or less protracted study or inquiry. Although more is involved than mere definitions, I believe that general recognition and use of definite meanings for the terms used to designate the different types of scientific inquiry will be a great help toward clearer thought and action on research programs. Instead of using the words research, investigation, study, and experiment loosely as synonyms, let us use them with the distinct connotations that belong to them. In this connection Dr. Carlton R. Ball, who is in charge of the Office of Cereal Investigation in the Department of Agriculture, states: "Not all quests for facts are to be called research. They may be mere observations, they may be surveys. Even where the experimental method is used, it does not follow that the process can be called research. It is better to separate these processes into three classes, which, in the ascending order of their difficulty, may be called experimentation, investigation, and research, respectively. No hard-and-fast line can be drawn between them.—At the same time, some such difference must be recognized if we are to be honest with ourselves and our problems." Professor Williams says that an answer

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to the question of what is research "may be reached directly by distinguishing research from its most closely related activities, namely, investigation and study." He adds study as a type of scientific inquiry.

One of the best dictionary definitions of research that I could find reads as follows. "Diligent protracted investigation, especially for the purpose of adding to human knowledge; studious inquiry. Specifically, in science, a systematic investigation of some phenomenon or series of phenomena by the experimental method, to discover facts or coordinate them as laws." Professor Williams' definition of research reads as follows: "Research has for its aim the discovery of facts, truths, and relations not previously known; its results are the extension of the field of knowledge." In E. E. Reid's "Introduction to Organic Research" we find this definition: "On closer examination research is simply re-search, the ordinary word 'search' with 're' prefixed, which means that if we search and do not find we must re-search—go back and search until we do find. Research is the process of discovering something new—adding something to the known." C. F. Kettering of the General Motors Research Laboratories, to quote still another authority, states briefly: "In simplest terms, research may be defined as an organized effort to obtain new information." In all these definitions there is agreement that the quest must be for something that is new, something that is unknown; it must add to existing knowledge. There is agreement also that the effort must be systematic; thoroughly organized. And most of the definitions maintain that the discovered facts must lead to a determination of laws or principles. None of the definitions of research indicates that the evolution of new technical or industrial methods for practical application is primarily an object in this form of inquiry. A practical need may be the reason for undertaking a piece of research work, but once under taken the aim of the research worker is to determine the underlying facts and principles and thereby bring full knowledge to the solution of the problem.

Investigation, on the other hand, is defined by Professor Williams as having for its aim "the understanding of the reasons and relations of things already known." He makes the distinction that investigation results in full comprehension and scientific discernment with regard to known facts whose relationship has not previously been understood, whereas the results of pure research go beyond this in discovering new facts and thus extending the field of human knowledge. Elsewhere investigation seems to be used largely as a synonym of research. One statement was found which implied that if there was any difference, it was one of degree rather than of kind. I believe, however, that the distinction here made between research and investigation is a sound one and should be adopted. Its application is more readily comprehended if we consider the common usage "Investigate the facts." This does not mean searching for new facts, but looking into the meaning of existing facts; determining their relationship.

Study, as a form of inquiry, is defined as having for its aim the acquirement of knowledge, not necessarily with the idea of discovering new facts and truths, as in research, nor even of seeking to understand the reasons and relationships of things already known, as in investigation. In forestry we make much use of this form of inquiry. We sometimes call the process a study, but most often incorrectly refer to it as research. To give an example, the effort may deal with finding out the condition of forest reproduction on a number of cut-over areas. The results are usually expressed in number and distribution and composition, by species, or seedlings per acre. On finding satis-

factory restocking in these terms, we look up the method of cutting practiced on the particular areas giving these results and have attained the object of our study. The process is a survey to ascertain results in order directly to formulate methods. A practical need is the reason for this form of inquiry.

Although there seems to be some variation among writers as to the meaning of experiment, there is agreement on certain of its attributes. For example, it is agreed that an experiment is a setting up of physical conditions, in which one of the variables is under control, and in which the object is usually to determine the results empirically, i. e., by experience. The purpose may not even be to discover something original, but may be merely for verification. In this connection, one of the dictionaries defines experiment, as used in science: "The arrangement of the elements or essential features of some object or process so as to permit controlled observation with a view to testing some hypothesis or theory." The aim of many experiments, in fact, is to test out or to adapt the conclusions from former work to a new locality, new species, or a new set of conditions. The aim of many experiments also is to get a relatively quick result without resorting to the detail of thoroughly organized research or investigation. In many cases this meets with the immediate need of the problem and of practice. The procedure in an experiment may be refined, or it may be by the so-called trial-and-error method. It should be pointed out here that when more experiments are performed or established under the same set of conditions than are necessary to test the validity of certain findings, the activity passes out of the field of inquiry into that of demonstration. Thus it is necessary to emphasize the distinction between an experiment made to obtain information and a demonstration designed to impart it.

My idea in presenting these distinctions between the forms of scientific inquiry is to call attention to the need of explicit language in dealing with research, and to provoke further thought on the subject.

MODIFICATION OF THE GUTZEIT METHOD OF DETERMINING ARSENIC*

J. R. Neller

State Experiment Station, State College of Washington

The Gutzeit method is essentially a colorimetric modification of the Marsh method with the advantages of being more rapid and equally accurate where extremely small amounts of arsenic are to be determined. It is essential, for the greatest possible accuracy of the method, that the impregnated strips should carry as nearly the same amounts of $HgBr_2$ as is possible to obtain. The procedure has been to cut drawing paper similar to Whatman's No. 40 cold pressed into strips 25 mm. wide, after which they were soaked in an alcoholic solution containing five per cent of $HgBr_2$. The impregnated strips were then laid out upon glass rods to dry, after which the ends were cut off and discarded as they may have carried an excessive and uneven load of $HgBr_2$ due to capillary movements of the alcohol as it evaporated from the paper.

To insure anywhere near an even distribution of the salt by this method it is necessary to draw the strips from the solution, one by one, with forceps and to make sure that they do not touch each other while drying. This is a slow and difficult procedure and it has been found more satisfactory to impregnate the sheet

*Presented at the Meeting of the Northwest Scientific Association Spokane, Wash., Dec. 27-28, 1929.

of paper before cutting it into strips. When this is done with the proper precautions, uniformly impregnated strips are easily obtained in a straight unrolled condition and ready for use.

In preparing the strips by this method a sheet of Whatman's cold pressed drawing paper—50 cen. long and 28 cen. wide —is loosely rolled and placed in a 1000 cc graduated glass cylinder. The alcoholic $HgBr_2$ solution is added in sufficient amounts to cover the paper which is allowed to soak for one hour. The roll is withdrawn with a glass rod hook and allowed to drain for a few seconds. It is then turned end for end and allowed to drain for a period of equal length. The paper is then waved back and forth from two to three times while held at one end so that it will unroll. The other end is then grasped and the paper waved back and forth for an equal period of time. The ends are again reversed and this process continued until the paper looks dry throughout its length. It is next placed upright between glass flasks to completely air dry. During the first part of this period it is well to turn the paper once so that the lower edge changes places with the upper edge. It is deemed essential to continually shift the paper end for end, as described above, to insure as even a distribution of the $HgBr_2$ as possible while the alcohol is evaporating.

Before cutting the paper into the 25 mm. strips a 5 cm. strip is cut from each of the edges and discarded. A lead pencil line is then drawn lengthwise across the paper a few centimeters from one edge. A portion of this line is carried on each of the 25 mm. strips and serves to mark the end of the strip that is kept uppermost in the Gutzeit apparatus. This marking tends to reduce irregularities, such as uneveness in the thickness of the paper and variations in the width of the strips that might be caused by the knife of the paper cutter. As thus prepared the strips remain straight and may be stored in a dessicator or some air tight vessel.

To determine whether the $HgBr_2$ was distributed evenly by this method triplicate determinations were made on several samples using strips cut from the center and both ends of the impregnated paper. The results obtained showed that the impregnation of the paper, before instead of after cutting it into strips, resulted in an even distribution of the $HgBr_2$.

To obtain as accurate a measure as possible of the length of stain that develops on a strip, it has been found convenient to draw lines across both sides of a strip at the points to which the stain has extended. The average length of stain is then measured by laying the strip down upon a graph constructed from standard stains obtained from known amounts of arsenic under conditions identical with those used for the analysis of the samples.

Among recent publications issued by the U. S. Department of Agriculture are soil survey reports on the Minidoka Area, Idaho, and Polk County, Oregon. Single copies of these reports may be had on application.

News and short articles on the activities of institutions and individuals engaged in scientific endeavor are invited.

For making geological investigations, the recent State Legislatures of Oregon Montana and Idaho made liberal appropriations, the respective Governors signing the bills. Washington was not so fortunate. A substantial bill providing for geologic, hydrographic and topographic studies in the field and publication of reports thereon, passed both houses but was vetoed by the Governor in the interest of economy.

ECONOMICAL DISTRIBUTION OF STEAM*

A. C. ABELL
Prof. Mechanical Engineering, State College of Washington

We learn from a study of the history of peoples that: So general is the knowledge of fire and its uses, it is a question whether we have any authentic instance on record of a tribe altogether ignorant of them. It is useless to inquire in what way man first discovered that fire was subject to his control and could be called into being by appropriate means. With the natural phenomenon and its various aspects, he must soon have become familiar.

Human culture may be said to have begun with fire, of which the uses increased in the same ratio as culture itself. To save the labor expended on the initial process of producing light or of carrying it about constantly, primitive man hit on the expedient of a fire which would burn night and day in some public building. We have gone far in our use of fire since these primitive times, but must go much farther in our methods of use, that out fuel resources may be conserved.

Coal, to the extent of 605,914,000 tons, was consumed in the United States in 1923, the last year of record. Of this quantity 86,914,000 tons were anthracite, the balance bituminous. Of the anthracite 60.2% went to the domestic trade, while the corresponding value for bituminous is 12.8%. These percentages of the total consumption and a great deal more, that is impossible of determination, are consumed in small isolated plants, which are very inefficient. The percentage of the heat value of the fuel, used in these plants, that is usefully employed is perhaps not over 40% and surely not over 50%. This does not mean that these plants are not capable of higher efficiencies, but simply that so little thought is given to the matter that better results are seldom attained.

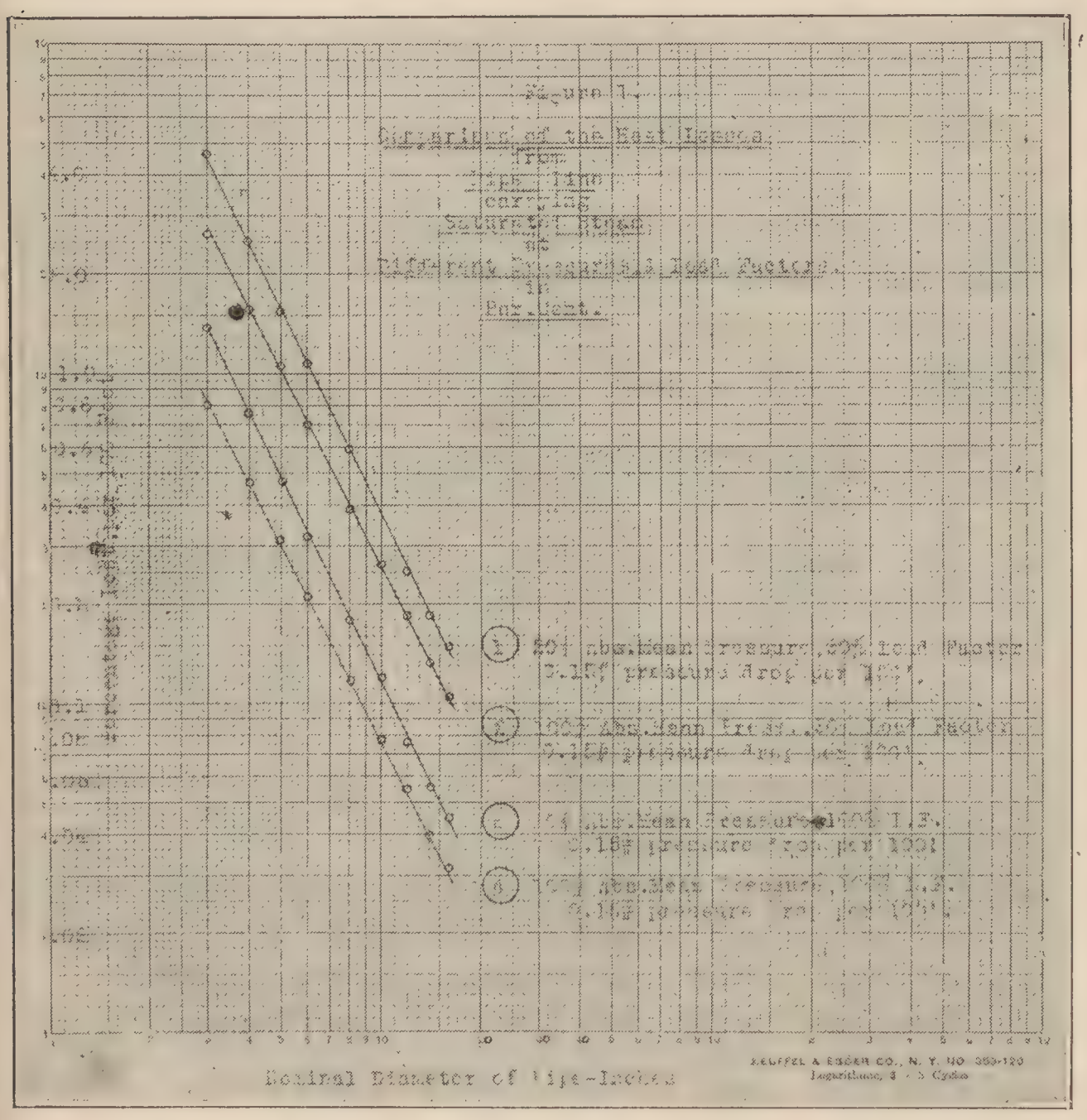
If the loads of these small isolated plants can be connected together and supplied from a central station, the savings in fuel will be very large. The efficiencies of central stations have steadily improved, until it is easily possible to have over all efficiencies of 80% for the boiler plant. In order that this advantage may not be lost, it is necessary to give attention to the method of supplying heat to the different units comprising the system.

Steam is the best carrying agent for the heat under these circumstances. The costs of transmission in a district heating system will consisit of the losses of heat consequent upon the transmission to comparatively distant points, the fixed charges on the pipe line and its insulation,together with charges on the conduit. Since the cost of conduit, whether it be tunnel or tile construction, will vary with every locality, it has not been considered in this paper. The losses, which will occur in a pipe line per unit of length, vary with the size of the line, the temperature difference between the pipe and the surrounding air, and the efficiency of the covering . These losses in B. T. U. have been determined by Mr. Dana of the State College of Washington Engineering Experiment Station, and are given in Bulletin No. 12.

Since in most applications of heat by means of steam, only the latent heat is considered as being available, the losses in pounds of steam may be determined by dividing the loss in B. T. U. by the latent heat at the mean pressure of transmission. (Only saturated steam considered here). This has been done for pipes of different sizes and for different mean pressures of transmission, the erent mean pressures of transmission, the results being shown in Figs. 1 and 2. In these calculations the line at 20 pounds

*Presented at the Meeting of the Northwest Scientific Association Spokane, Wash., Dec. 27-28, 1929.

absolute mean pressure was assumed to be covered with standard 85% Magnesia covering, while those at higher pressures were assumed to be covered with 2 inch, 85% Magnesia. It was further assumed, for purposes of this calculation, that steam at the building to be supplied was worth $1.00 per 1000 pounds, a figure which strikes a mean of the current prices. The unit of length chosen was 100 feet, as being the most convenient.



In order to show the effects of capacity of line and load factor, a uniform drop of .15 pound in pressure per 100 feet of line was assumed and the losses calculated in per cent of steam delivered for load factors of 100% and 30%, the latter being very close to the average for most heating systems, unless a considerable percentage of the load is used for process work, when it will likely be somewhat higher. From Figure 1, we find that for the 10 inch line at 20 pounds mean pressure, a loss of 0.120 of 1% per 100 feet will occur with a load factor of 100%, which will be increased to 0.38 of 1% with a load factor of 30%. This same sized line under a mean pressure of 100 pounds abs. will have a loss of 0.0760 of 1% with a load factor of 100% and 0.260 of 1% for a load factor of 30%. The saving of approximately 33% in losses due to the use of high pressure is largely due to the increased efficiency of the covering. The effect of using different pressure drops, from that assumed in this calculation would of course be to lower or raise the per cent loss as the pressure drop increased or lowered.

It will be noted, from Figure 2, that at 20 pounds absolute mean pressure the loss per season, of 210 days, from a 10 inch line 100 feet long will be $76. while this same line operating at 100 pounds mean pressure will suffer a loss of $100. per season, when steam is worth $1.00 per 1000 pounds. Other lines will show a similar variation in losses.

The cost for different sized steam lines, together with the necessary returns, both in place, have been calculated using the unit prices to the trade for both pipe and covering. These have been expressed on the basis of different allowable pressure drops per 100 feet and different mean absolute pressures of transmission. The results are shown in Fig. 3, as cost per pound capacity per minute. The cost per year, for a capacity of one pound steam per minute, using a 12 inch line with a mean pressure of 20 pounds and allowing a drop of 0.15 pounds per 100 feet, is $1.80, while that of a 6 inch line under

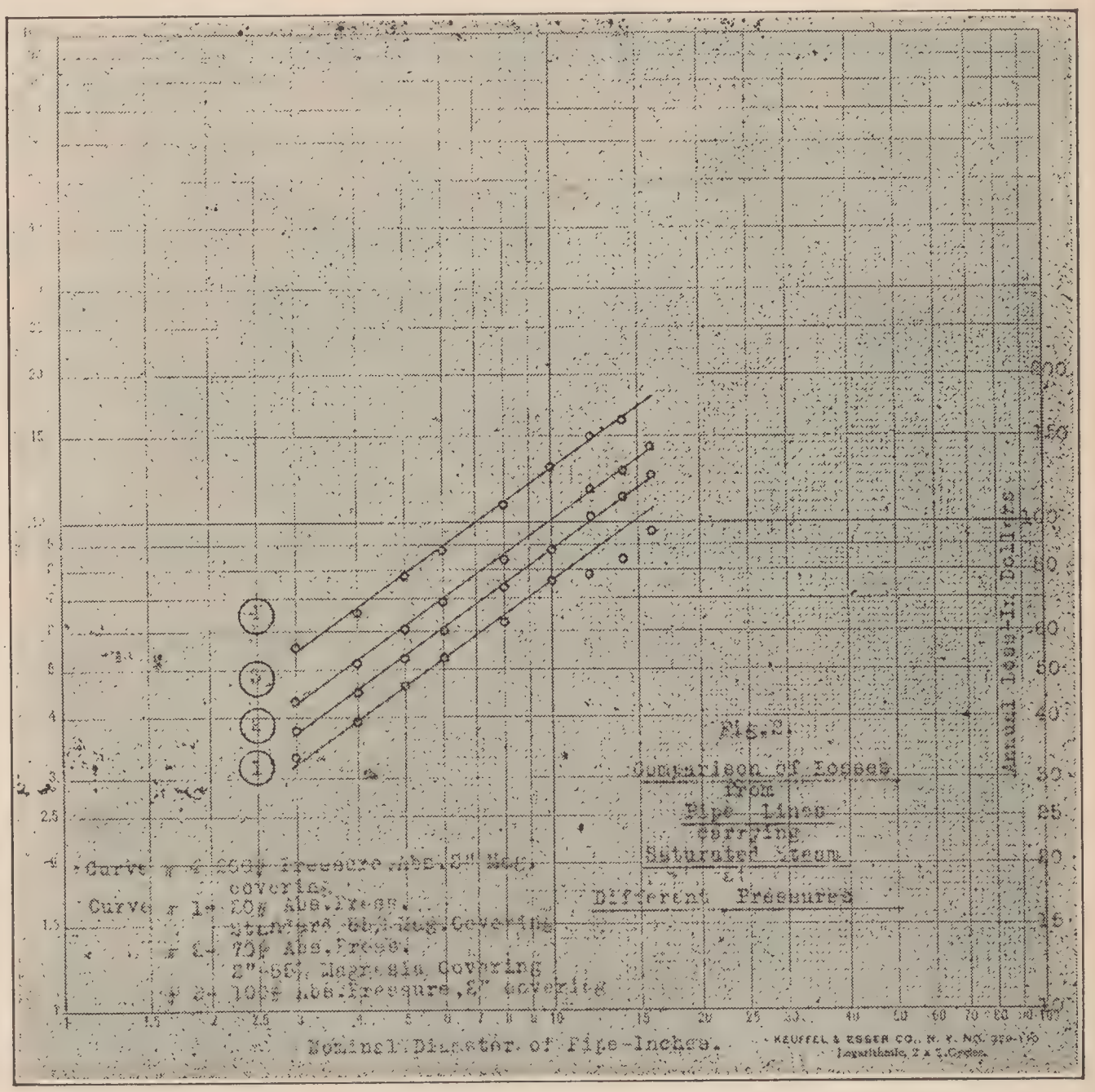
the same conditions will be $4.90. Comparing the cost of the 12 inch line, with a mean pressure of 20 pounds and a pressure drop of 0.15 pounds per 100 feet, with the same sized line but allowing a drop of 0.5 pounds per 100 feet, the costs are respectively $1.80 and $1.00 per 100 feet per year.

The costs of pipe lines may be expressed on the basis of fixed charges per year. This has been done using the following.

1. Life of the installation assumed at 25 years.
2. Interest at 7%.
3. Taxes at 2%.
4. Depreciation at 4%.
5. Maintenance at 2%.

(While this is not, strictly, a fixed charge, it generally varies directly with the size and cost of the line.)

From Fig. 3 the fixed charges on the 12 inch line just considered are $100. for a mean pressure of 20 pounds and $125, for a mean pressure of 100 pounds absolute, the difference being due to the increased cost of the covering. The figures for the 6 inch line will be $41.95 with 20 pounds pressure and $53. with a pressure of 100 pounds. In order to better bring out the effects of size and mean pressure of transmission, fixed charges have been figured per year on the basis of one pound capacity.


Annual Loss in Dollars
Nominal Diameter of Pipe-Inches.
Comparison of Losses from Pipe Lines carrying Saturated Steam
Different Pressures
Curve 1 = 20# Abs. Pressure, 2" Magnesia Covering
Curve 2 = 20# Abs. Pressure, Uncovered
Curve 3 = 100# Abs. Pressure, 2" Magnesia Covering
Curve 4 = 100# Abs. Pressure, Uncovered
KEUFFEL & ESSER CO., N. Y. No. 370-1/2

On this basis with the 12 inch line operating under a pressure of 20 pounds mean pressure and a drop of 0.15 pounds per 100 feet, the fixed charges per pound capacity are $0.16, while with 100 pounds mean pressure they are $0.102. The 6 inch line with 20 pounds mean pressure will have fixed charges of $0.4415 per 100 feet per pound capacity. Thus considering the cost of pipe line alone, the advantages lie with the larger pipe or larger system and with the higher mean pressures of transmission. The higher mean pressures are of advantage not so much from the fact that more steam will be transmitted in the same sized pipe due to the higher pressure, but that the higher pressure permits of a greater pressure drop and hence higher velocities.

As an example of the application of these facts to the determination of the best sized line to use for a given case, consider the following: 50,000 pounds of steam per hour to be transmitted 1000 feet. Assume a first case, steam generated at 10 pounds guage and allow a drop of 0.5 pounds per 100 feet. This will allow 5 pounds guage pressure at the building and a mean pressure of transmission of 22.5 pounds absolute.

As determined from a steam flow chart, this will require a 14 inch line.

From Figure 1, the losses per year for 100 foot line will be $90. or $900. for the 1000 feet.

From Fig. 3 the fixed charge will be $116. per 100 feet, or $1160, for the 1000 foot line.

Giving $2060. total charges per year for the 1000 foot line. With a load factor of 100% the total steam per year will be 50,000 x 24 x 210 (days in season) = 252,000,000 pounds.

RESEARCH AT UNIVERSITY OF IDAHO

IVAN C. CRAWFORD
Dean, College of Engineering, University of Idaho

At the meeting of Sigma Xi at Moscow, Monday evening, April 8th reports on the following pieces of research now under way in the University of Idaho were given:

Civil Engineering
- (1) Effect of Diatamaceous Earth on Expansion of Concrete
- (2) Potential and Developed Water Power in Idaho
- (3) Financial Status of Local Highway Units

Botany
- (1) Idaho Manual of Native Flora
- (2) Study of Freezing on Plant Tissue
- (3) Regeneration in Plants

Zoology
- (1) Nuclear Activity of a Young Squid
- (2) Abnormalities of a Kit-cat
- (3) Early Stages of Chick Embryo

Psychology
- (1) Use of Whole or Part System in Memorization

Forestry
- (1) Effect of Kiln Drying on Marketability of Idaho White Pine
- (2) Effect of Blue Stain on Absorption of Preservatives
- (3) Identification of all Species of Indigeneous Firs

Metallurgy
- (1) Relation of Classifier Efficiency to Grinding Efficiency
- (2) Power consumption of Discs and Other Machines Rotating in Oil

Agriculture
- (1) Control of Onion Thrip
- (2) Strains of Rhizoctonia and Solani on Potatoes

A BIOLOGICAL SURVEY OF THE INLAND EMPIRE

HAROLD ST. JOHN
Associate Professor of Botany, State College of Washington, Pullman, Wash.

At the 1928 annual meeting of the Botany-Zoology Section of the Northwest Scientific Association, the question of the feasibility of initiating a biological survey of the Inland Empire was discussed. No serious opposition developed, but several obstacles became apparent. The Section could not promise any funds, nor did any outside financial support seem available. On this basis, the Section voted to initiate the survey, and appointed the following committee to direct it: Harold St. John, Chairman; Thomas A. Bonser; Anthony J. Spuler.

The committee decided that under the circumstances they could not make any very large beginning. The plan agreed upon was to ascertain what institutions in the area had the equipment to care for collections and specialists willing to name them. When answers have been received, the committee will publish a summary, indicating what one or what several institutions are able and willing to care for collections of various groups of plants and animals. Collectors associated with the Northwest Scientific Association, as well as amateurs who are willing to cooperate will then know where they can get expert assistance on the various plant and animal groups.

The geographic area to be surveyed is the Inland Empire. That can be bounded as the parts of the states of Washington, Idaho, Montana, and Oregon lying between the crests of the Cascade and the Rocky Mountains.

Below are the names of the major groups of plants and animals. In order to ward off facetious comments, the committee wishes to explain that it is aware that the classificaion is not consistent. In some cases it goes down to families, while in others it stops at the phyla. The intention has been to subdivide to those groups that are usually dealt with by one specialist. Also the committee is not ignorant of the fact that some groups, as certain marine invertebrates, are not to be expected in the waters of the Inland Empire.

PLANTS

- Schizomycetes
  - Bacteriaceae
  - Spirillaceae
  - Phycobacteriaceae
  - Actinomycetaceae
  - Coccaceae
  - Myxobacteriaceae
  - Begiatoaceae
  - Rhodobacteriaceae
- Schizophyceae
  - Oscillatoriaceae
  - Scytonemataceae
  - Stignemataceae
  - Nostocaceae
  - Rivulariaceae
  - Chroococcaceae
- Myxomycetes
  - Acrasiales
  - Plasmodiophorales
  - Myxogasteres
- Flagellatae
- Dmoflagenatae
- Silicoflagenatae
- Bacillariophyta
- Conjugatae
- Chlorophyceae
- Charophyta
- Phaeophyceae
- Rhodophyceae
  - Arachnida
  - Phycomycetes
  - Ascomycetes
  - Basidiomycetes
  - Fungi Imperfecti
- Lichenes
- Hepaticae
- Musci
- Pteridophyta
- Gymnospermae
- Angiospermae
  - Monocotyledones
  - Dicotyledones

ANIMALS

- Protozoa
- Porifera
- Coelenterata
- Platyhelminthes
- Nemathelminthes
- Trochelminthes
- Molluscoida
- Echinodermata
- Annulata
- Arthropoda
  - Crustacea
  - Onychophora
  - Myriapoda
  - Insecta
    - Apterygota
    - Pterygota
      - Orthopteroidea
      - Neuroptera
      - Thysanoptera
      - Hemiptera
      - Diptera
      - Lepidoptera
      - Coleoptera
      - Mecoptera
      - Hymenoptera
  - Arachnida
- Mollusca
- Chordata
  - Adelochorda
  - Urochorda
  - Euchorda
    - Cephalochorda
    - Vertebrata
      - Cyclostomata
      - Pisces
      - Amphibia
      - Reptilia
      - Aves
      - Mammalia

Officials of institutions wishing to cooperate in this biological survey will kindly furnish the following information.

1. The name of the group or groups or fraction of group of plants or animals of which you would be willing to receive specimens.

2. Do you have a specialist on this group? Give his name, title, and address.

3. Describe briefly your facilities for storage of the specimens. Is the building fire-proof? Are the storage cases fire-proof? Are the storage cases insect-proof? Are they dust-proof? Are they safe from other hazards?

4. How many available specimens have you of this group?

5. How adequate is your library on this group?

6. How near up-to-date are you in caring for the accumulated collections?

The committee realizes that with no resources and little immediate prospect of funds that they cannot start an active Biological Survey. They believe that this

questionaire will reveal the nature of the existing biological collections. It will reveal where others may turn for expert opinion and for authentic material for comparison. When given publicity, it may enlist the help of a good many amateurs. This will develop the existing collections, and will make the framework of a Biological Survey. The task ahead is gigantic, one that will take generations, but we can make the start.

Please send replies to:

Dr. Harold St. John,
Botany Dept.,
State College of Washington,
Pullman, Wash.

The paper by Dr. I. T. Haig on Accuracy of Quadrat Sampling which was read before the Forestry Section of the December 27-28, 1928 meeting of the Northwest Scientific Association is to be published in ECOLOGY and reprints will be sent to the members of the Association gratis through the courtesy of the author.

U. S. Geological Survey Bulletin, 805-B on the "Deposits of Vermiculite and Other Minerals in the Rainy Creek District, near Libby, Montana" by J. T. Pardee and E. S. Larsen, has been published. Bulletin 805-A on "Platinum and Black Sand in Washington", by J. T. Pardee, was previously published.

ADVANTAGES OF THE JUNIOR COLLEGE*

GEORGE W. WALLACE
Department of Education, State Normal School, Cheney, Wash.

A major problem of educational reorganization which is, or soon will be, demanding solution in the state of Washington and many other western states is that of the public junior college. As a result many questions are being asked about the junior college and the considerations involved. Not the least in importance among these questions are those relating to possible advantages from a new plan of organization. The following report describes a study made at Stanford University in the summer of 1928 which shows something of the advantages claimed for the junior college by those in charge of such institutions at the present time.

The study to determine the chief bases of appeal of the junior colleges was made thru a survey of junior college catalog material. All the latest public junior college catalogs in the Stanford Education library were consulted. Most of the catalogs had been received by the library in June 1928 and were apparently the latest available. The academic year for which most of them were issued was 1928-9, tho some of them were dated 1927-8 and 1926-7.

Catalogs from a total of 54 junior colleges were included in the study. This probably represents about 40% of the total number of public junior colleges in the country last year. The location, according to states, of the public junior colleges represented by catalogs was as follows.

California, 22
Michigan, 5
Texas, 4
Arkansas and Minnesota each 3
Two each from Georgia, Illinois, Kansas, Kentucky, and Washington.
One each from Iowa, Missouri, New Jersey, Oklahoma, Tennessee, Utah, W. Virginia.

The method employed was to collect the data from the catalogs for analysis and tabulation. To find out the chief

*Presented at the Meeting of the Northwest Scientific Association Spokane, Wash., Dec. 27-28, 1929.

bases of appeal of each junior college an attempt was made to find specific statements in its catalog as to aims, purposes, functions, or advantages. All such statements of a general nature which appeared significant were collected and retained for analysis and tabulation.

In analyzing the statements found as to aim, purpose, functions or advantages twelve main bases of appeal were noted. These were as follows:

1. Two years of college preparation
2. Terminal education facilities
3. Economy for the individual
4. The meeting of local needs
5. Individual attention
6. Transition opportunities
7. The continuance of home influence
8. Teacher training
9. Better university preparation
10. The popularization of higher education
11. Better leadership training
12. Appropriate location of subject matter.

"Two years of college preparation" means the giving of two years work to collegiate grade that will be accepted toward graduation by standard four year collegiate institutions. After choosing and following certain lines of study in the junior college for two years the student will be able to enter a four year college as a junior and complete the work for a bachelor's degree in two years. Tho some of the catalogs mentioned this purpose only indirectly it was assumed that all the junior colleges studied included it among their functions.

"Terminal education facilities" refers to the offering of the junior college for those students who are not "going on" to complete a four year collegiate course. 28 of the 54 junior colleges studied offer courses designed to complete the work of students of this group.

"Economy for the individual" refers to comparative costs to the individual student. It was assumed by the public junior colleges that college education near the pupil's home was less expensive than that which could be gotten elsewhere. 22 catalogs or more than 40% of those represented in the study claimed this advantage.

The Ability to "meet local needs" ranked fourth among the bases of appeal tabulated. Statements varied from the mere advancement of the claim to detailed discussions of how the school represented was actually meeting local needs. One third of the junior colleges in the catalog study attempted to show how the ability to meet local needs was an advantage.

"Individual attention" implied an enrollment sufficiently limited to permit real individual attention of the sort that would not be possible in a larger institution such as a great university. 17 of 54 catalogs used the individual attention idea as a basis of appeal.

"Transition opportunities" refers to the idea of "bridging the gap" between the secondary school and the standard four year college or the university. Certain junior colleges maintain that the high school and college are very dissimilar in nature, so that the junior college provides the proper transition period between them. 25 of the 54 junior colleges represented in the study were of this opinion.

The appeal listed as "the continuance of home influence" explains itself. 12 of the public junior colleges believed they offered this advantage.

"Teacher training" might be considered terminal education, but it was felt that sufficient emphasis was placed upon it in the catalogs to warrant its being considered separately. Most of the teacher training was for elementary school work, tho some of the catalogs promised certification for high school teaching after a

prescribed junior course. The teacher training advantages offered were mentioned by 12 of the 54 public junior colleges studied.

"Better university preparation" means that the junior college feels that it provides better preparation for the last two years of work toward a bachelor's degree than do the first two years of the four year college or the first two years of the university. 16.6% of the junior colleges studied included this among the advantages claimed.

"The popularization of higher education" refers to influencing more individuals to profit from the advantages of college training. 14.8% of the catalogs claimed the popularization advantage for junior college.

"Better leadership training" or facilities for more effectively furthering the development of a strong personality was a claim advanced in 7 of the catalogs.

"Appropriate location of subject matter" refers to the idea that the appropriate location of the subject matter of the first two years of the traditional four year college or university is the secondary school. In this connection the junior college is conceived of as part of secondary education. This claim was found in three of the catalogs.

The main advantages claimed by the public junior colleges in their latest available catalog statements, then, are:
able catalog statements, then, are as cited above.

Of these advantages claimed the first, viz. "two years of college preparation", was mentioned by 54 or 100% of the schools studied.

28 or 51.8% mentioned "terminal education facilities"

22 or 40.7% mentioned "economy for the individual"

18 or 33.3% mentioned "the meeting of local needs"

17 or 31.5% mentioned "individual attention"

14 or 25.9% mentioned "transition opportunities"

12 or 21.1% mentioned "the continuance of home influence"

12 or 21.1% mentioned "teacher training"

9 or 16.6% mentioned "better university preparation"

8 or 14.8% mentioned "the popularization of higher education"

7 or 12.9% mentioned "better leadership training"

3 or 5.5% mentioned "appropriate location of subject matter"

In a similar study of 65 private junior colleges 100% of them mentioned "two years of college preparation" as an advantage; 40% listed of them mentioned "terminal education" among their functions; 35.3% used the idea of "individual attention" as a basis of appeal; 23% gave some emphasis to "teacher training"; 12.3% offered "transition opportunities"; 12.3% claimed to give "better leadership training"; 9.2% maintained they offered "better university preparation"; while 6.2% appealed on the basis of "economy for the individual".

Whether or not the typical public junior college will actually offer all the advantages here claimed for it remains to be seen.

Mr. Howard A. Powers, a former graduate of the University of Oregon and for the several past years a graduate student in the department of Geology, Harvard University, is now writing his doctor's thesis on the Modoc Lava Beds. He will presently join the U. S. Geological Survey and establish headquarters in the Volcano House, Hawaii, to make further study of volcanology.

RECOVERY OF VANADIUM

ALFRED OBERLE, Ph. D., Kansas City, Missouri

The following items on the recovery of vanadium from petroleum hydrocarbons are contributed by Dr. A. Oberle, of Kansas City, Missouri, in the hope that they may be of interest to the readers of Northwest Science.

OCCURRENCE

Mineral oils, especially those from Mexico (Panuco), Persia, Argentina, Roumania, Burma, Java, Borneo; the oils from Texas, California, and Oklahoma contain vanadium in varying amounts.

Asphalts, Pitches, Coal and *Shale* also contain vanadium in varying amounts.

Asphalts of Peru contain up to 15% vanadium (based on asphalt, not its ash). The ash of Oklahoma Oil contains 22.4% vanadium.

The *Source of Supply* in the past for vanadium has been from the minerals carnotite, vanadinite, roscoelite, patronite, and mottramite. These minerals contain varying amounts of vanadium in combination with iron, sulphur, lead, copper and uranium. Peru has furnished 90% of the world's supply of vanadium from patronite. The patronite mines are located in the Peruvian Andes at an elevation of 16,000 feet.

RECOVERY (OLD)

Vanadium ore, as it is mined, has to be reduced, washed, treated with an alkali, roasted, leached, evaporated, treated with acids, reduced in an electric furnace, and the admixtures, such as silica, iron, sulphur compounds, etc. have to be removed from the final product by special processes.

RECOVERY (NEW)

It is proposed to recover vanadium from petroleum coke and the like material by burning the coke, etc. as usual under the boiler, the ash being leached or extracted simply by blowing steam from below into the incandescent fuel bed or by dropping the ashes into a container of water below the grate, or bubbling the flue gases, carrying vanadium, through water, or slightly acidulated water, and evaporating the water. The red vanadium pentoxide crystals form readily on evaporation of the water.

The introduction of steam has the additional advantage of protecting the fire grates and of a greater heat economy, such as production of water gas and a diluent for the heavy fumes given off from freshly fed petroleum coke.

ECONOMIC ASPECT

In 1927 there was produced in the United States a total of 1,450,000 tons of petroleum coke. Of this amount, 450,000 tons has been burned.

Petroleum coke contains from 0.5—3% of ash. This ash contains 1.5—22.4% of vanadium. Vanadium is at the present time produced by the Vanadium Corporation of America at a cost of $3.35 a pound.

In 1906 the world consumption of vanadium was 750 pounds. In 1924, the vanadium consumed in the United States was 991,900 pounds and it is predicted that, in 1930, the world consumption of vanadium will be 2,600,000 pounds, worth approximately $8,700,000, at the prices current for the past three years.

USES

Metallurgy: It increases hardness and toughness and resists fatigue.

Oil Industry: As a catalyst.

Paint Industry: As a drier.

Medicine: Infectious disease.

Optics: Prevents ultraviolet rays passing through glass.

Its properties resemble closely those of tantalum and it may soon find application in the electric industry.

THE TWO SPECIES OF BUNT ON THE SAME PLANT*

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Department of Agronomy, State College of Washington—2

In 1873, Kuhn (3) distinguished between *Tilletia levis* and *Tilletia tritici* on the basis of spore characters. Neither at that time nor since that date has any evidence been produced to show that host infection by one species is in any way different from infection by the other. It is then of interest and of some importance to determine how frequently spores of both species are produced on the same plant when inoculum, either natural or artificial, of both species has been available.

Some reference to this point has been made in previous work. In 1918, Potter and Coons (4) report that in their work with bunt, "a few heads were found with sori containing spores of both species". This might imply that in these few heads, some sori had spores of *T. levis* while others contained spores of *T. tritici.* More probably, however, it implies that individual sori contained spores of the two species. In a study on winter wheats inoculated with a mixture of spores of the two species, Woolman (5) "frequently found heads of both species of bunt in the same plant; in one instance, *T. tritici* and *T. levis* were found in the same head".

In some work done at the State College of Washington on the pathogenicity of a number of collections of bunt, it was found desirable to determine more definitely how frequently the two species of bunt might be associated in the same plant.

Materials and Methods

Ten varieties of winter wheat had been used as differentials in an attempt to distinguish between five bunt collections. In addition, seeds of each of these varieties were inoculated with a mixture of spores from these collections. This mixture contained approximately 80 per cent of spores of *T. levis* and 20 per cent of *T. tritici.* These varieties were sown in the fall of 1927, the seeds being planted two to three inches apart. Similar inoculation was carried out on ten varieties of spring wheat sown in April, 1928.

From the varieties inoculated with mixed smut, two which had shown susceptibility to the individual collections were selected, one, a winter wheat, Hybrid 128 (Wash. 592), and the other a spring wheat, Bluestem (Wash. 265). At harvest, smutted plants in these rows, after being pulled, were carefully examined so that in no case should two plants which might happen to be growing side by side be tested as one. All the heads were collected from each plant and all from one plant put in one envelope. In the examination of spores from this material in the laboratory, each smut ball examined was cut longitudinally into two parts with a clean scalpel and spores were taken from a number of points on one of the cut surfaces.

Results

In the preliminary test, spores from one smut ball from each head of 14 plants of Hybrid 128 and of 17 plants of Bluestem were examined under the

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2 The writer is indebted to Dr. E. F. Gaines and Dr. F. D. Heald for helpful suggestions in this study.

3. Kuhn. Julius. Tilletia laevis. Hedwigia 12: 152-153. 1873.

4. Potter, A. A. and Coons, G. W. Differences between the species of Tilletia on wheat. Phytopath. 8: 106-113. 1918.

5. Stephens, D. E. and Woolman, H. M. The wheat bunt problem in Oregon. Oreg. Agr. Expt. Sta. Bul. 188. 42 pp. 1922.

microscope to determine whether all the heads on any plant showed the same smut species. The results are shown in Table 1.

Table 1.—Presence of **Tilletia levis** and **T. tritici** in susceptible varieties inoculated with spores of both species in the ratio 4:1.

Host	Plants examined	Heads per plant		Number of plants				
		Range	Average	Only levis	Only tritici	Both levis and tritici		
						Plant No.	Heads of levis	Heads of tritici
Hybrid 128 Sown Oct. 29...	14	6-24	13.3	8	1	No. 4*	3	13
						No. 8	6	6
						No. 10	14	3
						No. 12*	10	9
						No. 13	13	11
Bluestem Sown Apr. 14...	17	5-17	10.4	7	0	No. 2	7	1
						No. 3	8	5
						No. 5	3	2
						No. 6	11	1
						No. 7	2	15
						No. 8*	6	4
						No. 11*	11	1
						No. 14*	6	9
						No. 15	13	2
						No. 17	5	4
Total	31		11.7	15	1	15		

Plants marked * were examined later in more detail.

Of the 16 plants in Table 1 showing only one species of smut, 15 had *T. levis* while only one had *T. tritici.* From the proportion of rough to smooth spores in the inoculum—80 per cent *T. levis* and 20 per cent *T. tritici*—one would expect a ratio of approximately four to one if the two species were of equal virulence on these varieties. Tests of the two varieties to the individual collections showed that both varieties had approximately the same degree of infection with each collection. But since the deviation of the fifteen to one ratio from the expected is not more than twice the propable error, it can be considered as a chance deviation.

The most significant feature in Table 1 is that 15 out of the 31 plants examined produced spores of both *T. levis* and *T. tritici.* Such a result would be in accordance with one of the suggestions made by Heald (6) to explain the results obtained in experiments on the relation of the spore load to the percentage of stinking smut appearing in the crop. Heald found that the percentage of smut increased as the spore load increased from a very small quantity to something approximating 36,000 spores per kernel and suggested that multiple infection may occur, that is, an infection in which a number of spores participate. Although this work was done with *T. tritici,* it appears from the present study that spores of both species may participate when both are present in the inoculum. On the other hand, the fact that approximately 50 per cent of the plants had only one species of smut suggests that either

6. Heald, F. D. The relation of spore load to the percentage of stinking smut appearing in the crop. Phytopath. 11: 269-278. 1921.

the mycelium from relatively few spores can continue growth into the culms or that there is antagonistic action between the mycelium of the two species in the tissues. In the latter case, the mycelium of the species which first gets the upper hand crowds out the other.

Having determined that infection by both species took place frequently when spores of the two species were present in the inoculum, a more detailed examination of the smut balls of plants which had both species of spores, was made. Observations were made on approximately nine smut balls taken at random from each of all the heads of five such plants. The data are presented in Table 2.

Table 2.—Frequency of the occurrence of the spores of **Tilletia levis** and **T. tritici** in the same smut ball in five plants infected with the two species when examination was made of an average of 8.4 smut balls per head.

Host	Heads of Each Species
Hybrid 128	
Plant 4	2 **levis**
	13 **tritici**
	1 **levis** and **tritici** (4 smut balls **levis**
	(4 smut balls **levis** and **tritici**
Plant 12	10 **levis**
	9 **tritici**
Bluestem	
Plant 8	6 **levis**
	4 **tritici**
Plant 11	11 **levis**
	1 **tritici**
Plant 14	6 **levis**
	8 **tritici**
	1* **levis** and **tritici** (7 smut balls **tritici**
	(1 smut ball **levis** and **tritici**
Total	72 heads

*Although only 1 smut ball having the two species was found in the first eight examined in this head, the examination of the remaining 19 smut balls showed two having spores of both species, the other 17 having **T. tritici** only.

The frequent association of the two species in the same plant might lead one to expect the two species to be present frequently in the same head. Table 2, however, shows that at any rate in this material such is not the case. Of the 72 heads examined, only two showed *T. levis* and *T. tritici* within the same head and in this case, spores of both species were present in each of four smut balls on one head and in one smut ball on the other, that is, of more than 600 smut balls, only five showed the two species. In order to determine whether this test was sufficiently reliable, further examination was made. For each head, the remaining smut balls were dissected out, washed in running water and then in sterile water. The smut balls were then broken so that a suspension of the smut spores from each head was obtained. A quantity of the suspension was then examined on a slide under the microscope. This test showed that there was no admixture of the two species present in any head other than those mentioned above. When one considers that all of these five plants had some heads of *T. levis* and some of *T. tritici,* the number of heads showing the

two species is strikingly small. Such a situation may be due to either the ability of one mycelial growth to crowd out any other or to some antagonistic action between the mycelium of the two species.

Striking differences were observed in the amount of reticulation or ridging on the spores of *T. tritici.* Usually all the smut balls in one head showed approximately the same degree of spore reticulation but sometimes in a head some smut balls would have well-defined spore markings while others would have indistinct markings. It has not been determined whether these differences are due to environmental or hereditary factors.

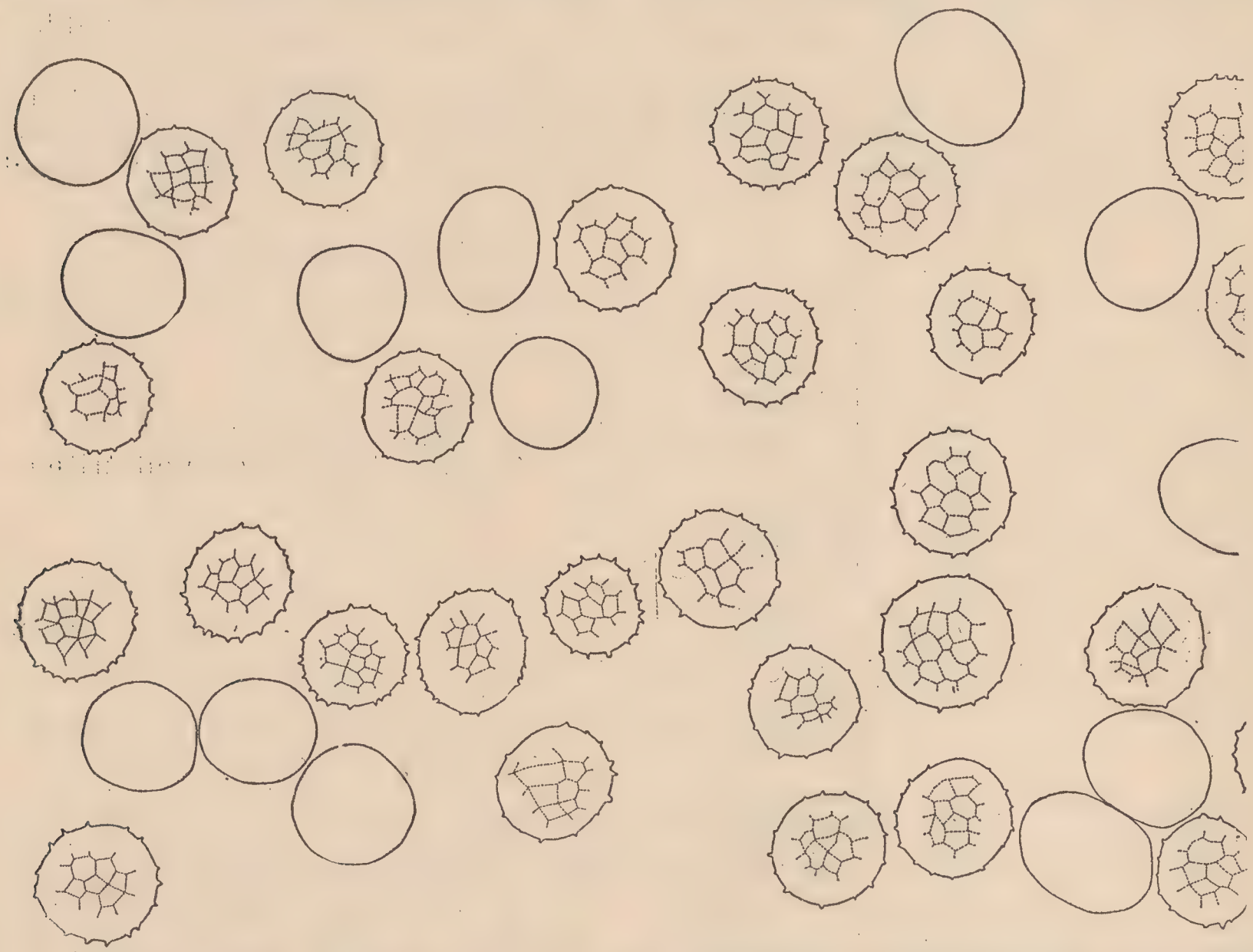

Fig. 1. Camera lucida drawings of spores from a smut ball containing the two species of bunt. The unbroken line represents the outline of the spores when this outline was in focus, while the broken line represents markings apparent when the surface of the spores was in focus. It will be observed that in the small number of spores represented, some of the smooth spores have the elliptical shape typical of a proportion of the spores of T. Levis.

Tisdale et al (7), in a study of the distribution of *T. levis* and *T. tritici* in 1926, state "that the spores of *T. tritici* varied from very echinulate to almost smooth, that, in fact, the two species seemed to merge or overlap in this respect". In the present study, there was no indication of overlapping; spores of *T. tritici* having only faint reticulations were distinct from the smooth spores of *T. levis.* The smut balls having spores of the two species in this study contained reticulate spores typical of *T. tritici* and smooth spores typical of *T. levis* (Fig. 1).

In one of the heads in which admixture was observed,—in that of plant 4 of Hybrid 128—an attempt was made to determine the proportion of spores of each species in different parts of the smut balls. This head had some smut balls of *T. levis* only and some of both *T. levis* and *T. tritici.* There were marked differences between some of the smut balls. For example, one of these showed 73 per cent of spores of *T. tritici* in the germ end, 76 per cent in the brush end with only 8 per cent of *T. tritici* in the centre; another showed 64 per cent of *T.*

7. Tisdale, W. H., Leighty, C. E. and Boerner, E. G. A study of the distribution of Tilletia tritici and Tilletia levis in 1926. Phytopath. 17: 167-174. 1927.

tritici in the germ end, 80 per cent in the brush end, 89 per cent in the centre and only 11 per cent of *T. tritici* spores near the surface of the smut ball.

From these results, it is apparent that the spores from one head of a smutted plant do not give a reliable indication of the smut species present in a plant. It is necessary to examine each head. Only under special circumstances is it necessary to examine more than one smut ball per head, even when both species are found on the same plant. In no case was a smut ball containing one species found along with one containing the other species in the same head; only two heads out of 72 contained spores of both species in the same smut ball.

A STUDY IN METHODOLOGY*

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Having read an abundance of material on the many methods of classroom procedure to be found in the educational world to-day, the writer decided to do a little experimenting with the end of determining for himself, whether or not any validity might be attached to the claims of proponents of one method as compared with those made by partisans of another method. Being in some measure familiar with the Dalton Plan, the socialized recitation, the project and the problem plans, what might be termed the Miller plan, the supervised study plan, and others, some sifting had to be done before a plan of action could be decided upon. Inasmuch as I was teaching three classes in economics I thought it best to begin my experimentation in these classes and so I decided to employ three different procedures. My plan was to teach each of the three classes by two different methods, employing each method for half of the term. This plan was followed and the procedures decided upon were the socialized, the contract, and the regular or old-type of classroom method. I was unprejudiced against any particular method, and I was not aware of any desire or even inclination to have any type of procedure come boldly to the fore as THE method. I wanted to teach these methods as they were being presented in other centers, and then let the results speak for themselves. I was in hopes of discovering which method was the most satisfactory for my use, whether the study had any value beyond that or not.

The classes were given Terman's Group Tests A and B, and the highest grade of the two tests was recorded. The results showed that Group I had a median score of 175; that Group II had a median score of 172; and that Group III had a median score of 161. (It is well to note that this is not the intelligence quotient.)

Being aware of claims made for some methods that they stimulated the pupils to thought and that they were efficient brain developers, it seemed that it might be well to test this by examination. Accordingly I gave each class three separate and distinct examinations, employing the essay, the objective, and the problem types of tests. Each class took the same tests so that there would be a basis for comparison but they were not aware of fact that this was being done.

It might be well at this point to indicate in a general way, what the major differences in the methods employed were. By the regular method of course is meant the question and answer method in large part, in which the teacher is the dominant figure in the classroom and the child *re-*

*Presented at the Meeting of the Northwest Scientific Association Spokane, Wash., Dec. 27-28, 1929.

cites the assignment required by the instructor. The socialized recitation requires that the classroom formality be considerably changed, and that pupil participation and direction of the class supersede in part that of the teacher in the regular way of teaching. The teacher directs, indirectly since it is required that he remain very much in the background. Students discuss the point of the lesson among themselves. Student leaders elected by pupils themselves direct the recitation, but the teacher keeps in touch with these leaders getting the leaders to put over the work as he thinks it should be done thus performing his work indirectly. The teacher is the final arbiter of mooted problems and of course must be alert to see that everything functions smoothly and orderly. The contract plan, which in some ways is a modification of the so-called Dalton plan, is of such nature as to require that students do a certain amount of work for one grade, and so much more to get a grade higher than that, and so on. The regular recitation is passe, and is superseded by units of work which must be done in a certain time, after which examinations are given. Pupils may or may not take part in class discussions, but all must be attentive to the pre-view of the units as given by the teacher. This is necessarily a very brief statement of the various procedures followed. The classes were graded on the frequency curve.

As a minor part of this study I undertook to determine whether or not one particular type of lesson procedure required more or less time in preparation than did other types, and to that end a questionnaire was prepared with that intent in mind. The pupils recorded each day in all three classes the amount of time they spent on their lesson preparation. It was distinctly understood that these recordings would in no wise militate against or for their class standings.

Results

		GROUP I med.	GROUP II med.	GROUP III med.
I.	Intelligence Score	175	172	161
II.	Ave. Time Daily			
	Contract	57″	49″	47″
	Regular	49″		——
	Socialized	——	73	76
III.	Exam Grades			Ave.
	Essay)		60	85—73
	Problem) Social		70	80—75
	Obj.)		76	70—73
	Essay)	75	74	82—78
	Problem) Cont.	80	82	76—78
	Obj.)	74	75	83—79
	Essay)	68		68
	Problem) Regular	86		86
	Obj.)	75		75
IV.	Class Wk. Ave.			
	Contract	82	78	83
	Socialized		73	76
	Regular	82		——
V.	Class Ave.			
	Contract	83	80	80
	Socialized	—	76	83
	Regular	82	——	——

Thru a study of the accompanying chart it will be readily seen that there is nothing to indicate that one type of lesson is better in group one than is the other. In group two it appears that the contract method was 4 points better on the average than was the socialized method. This is somewhat changed in group three which gives the socialized a three point advantage over the contract method. From these findings it is quite evident that one type of lesson plan offers no real advantage over another type, although there is a distinct difference in the teaching of them. The contract method requires most teacher time both in and out of school, and the socialized recitation is the most difficult to establish and keep moving so that a few do not do all of the reciting and furnish all of the leadership in a class.

The regular group bested the socialized group by eleven points on the problem type of test and it was seven points better than were these groups which were taught by the contract method.

The contract groups averaged 78 on the essay type of tests, which bettered the

average of the regular group by ten points, and that of the socialized group by five points on an average.

The contract group also received the highest average on the objective tests which was 79, contrasted with an average of 73 received by the socialized group and of 75 received by the regular group.

However when class grades are computed with examination grades there is not conclusive evidence to support the contentions of any one group of its superiority with reference to other types of lesson procedures.

With reference to the time element in lesson preparation, the chart requires little amplification. With the exception of one class taught under the contract method, there is little to show that one plan requires a greater amount of preparation than do other plans. It is interesting to note that group one which had the highest intelligence test scores received an average grade under both types of procedures of 82.5. Group two maintained an average of 78 in both types and group three of lowest intelligence quotients, received an average grade of 81.5. This calls our attention to the fact that those with the highest I.Q's are not necessarily those who do or do not get the highest grades.

The experiment while worth while from the standpoint of giving the writer more familiarity with the trends in methodology from the laboratory standpoint, did not prove to his satisfaction that any conclusions might be drawn of a positive nature without more experimentation in the field of his enterprise.

PROGRESS REPORT ON A STUDY OF RHYTHMIC CORRUGATION IN HIGHWAYS*

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[1.] *Dean of Mechanic Arts and Engineering,* [2.] *Research Engineer, State College of Washington*

The study of washboards in highways undertaken in the State College Engineering Experiment Station has been progressing rather slowly. First, we studied the relative motion of the rear axle and the car body of a Ford car. This showed the greatest axle vibration to come at about 17 to 20 miles per hour, thus indicating a resonant condition. Other evidences of this were found in this and other cars. Complicating vibrations prevented accurate study in this way so later a laboratory model was made. In this model conditions in the car and road could be imitated without effects coming from the front axle and definite results were reached as outlined in Station Bulletin No. 19.

There remained the need for actual road tests made in such a way that washboards could be made by a car operating under known speed and other conditions. This has been done in part during the past summer. A circular track, banked for a speed of 20 miles per hour was graded up and surfaced with crushed basalt. A Ford Model T equipped with high pressure tires and no shock absorbers was tried and it was found that washboards would be definitely formed in about 100 trips of the car at 20 miles per hour with the tires pumped up to 55 pounds. Reduction in either speed or tire pressure reduced the speed of formation of the corrugations.

Addition of shock absorbers at all four wheels eliminated all tendency to form washboards at least at speeds up to 20

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miles per hour, the speed limit of the track. Addition of baloon tires also prevented the formation of washboards at any speeds up to our limit of 20 miles per hour. Attempts to form washboards failed although the car was driven some 3600 trips over the track. Baloon tires were tried over the track after washboards had been well started with the high pressure tires. It appeared that the baloons had no appreciable effect either to build up or tear down the corrugations.

The mathematical analysis and the laboratory tests described in Bulletin No. 19 indicated that at some speed not far above resonant speed for the washboards a car should begin to tear down instead of build up the corrugations. It has been impossible to check this with the small track used during the past summer, but it is hoped that the questions remaining can be answered next summer. These questions are as follows: Will baloon tires cause washboards at any ordinary speed? If so, will shock absorbers prevent it? Are shock absorbers needed on both front and rear to prevent the trouble?

Our studies have emphasized the fact that the general public does not appreciate the tremendous expense of controlling the washboards. Our tests show that highway maintenance could be reduced to a very small fraction of the present figure if washboards were eliminated because the grading or planing needed to control them is not only the principal item in current maintenance but it is necessary in this planing to tear down large quantities of well compacted macadam and to maintain a loose dusty road surface which causes rapid loss of road material. These things, when taken with the annoyance and discomfort caused to travelers and the added upkeep of cars make up an enormous total which we are all helping to pay. If further tests prove, as seems likely, that baloon tires, or shock absorbers, or both combined, are effective to prevent washboards at the usual highway speeds; then, if each driver with high pressure tires and no shock absorbers were required to pay a toll commensurate with the damage he causes, the cause would rapidly disappear and the guilty driver would soon save his cost for baloons or snubbers in reduced upkeep on his machine.

NOTE ON A LABORATORY AIR THERMOMETER*

B. L. Steele

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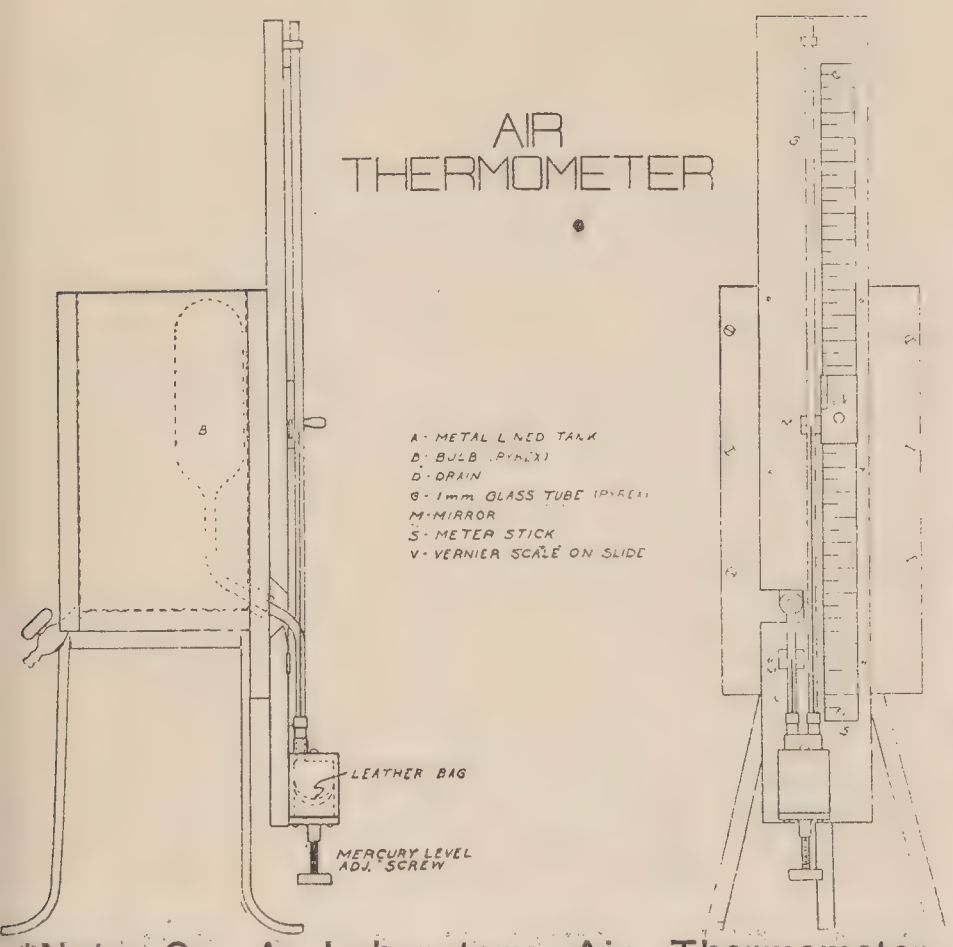
A very widely used laboratory experiment in College sophomore physics is that of determining the pressure coefficient of expansion of air. The form of apparatus here described has been developed to obviate several of the major objections to the usual forms. These objections are: They are clumsy, they are too easily broken, and the mercury is fouled by the rubber tubing. The accompanying diagram shows the essential details of the construction.

The amount of air in the capillary, which is not subject to the temperature change, is so small a fraction of the total volume of the air as not to require a correction to be made for it. In the particular apparatus shown the mercury reservoir is made of paraffine-impregnated glove leather. A steel chamber with a corrugated steel bottom answers equally as well or better.

*Presented at the Meeting of the Northwest Scientific Association Spokane, Wash., Dec. 27-28, 1929.



*Note On A Laboratory Air Thermometer

The consistency of the results obtained by the apparatus is shown by the following values of the coefficient of expansion which are the results of series of nine consecutive experiments:

0.003666	0.003692
0.003674	0.003663
0.003664	0.003683
0.003664	0.003669
0.003683	ave. 0.003673

EDITORIAL NOTES

Of the contents in this number of Northwest Science there may well be special mention which for the most part constitutes papers presented at the last annual meeting of the Northwest Scientific Association and without detracting anything from those articles not mentioned here attention is specially called to some items which for one reason or another are timely, represent contributions which seem to the authors and the editor as pointing the way to avenues of interest which may well be emulated, or have some common interest. Thus: Zoning is just now attaching more than commo i importance to everyday life in almost every up to date community; there is need for greater correlation of scientific endeavor as is pointed out in "Aspects of Present Manuals," etc; the question of "What is Research," is intelligently dealt with; "Research at the University of Idaho," a contribution to show what one institution is doing; "A Biological Survey," is certain to attract more general attention to a subject of great importance due much to the manner of its presentation and serves as a factor to determine the interest which may be taken in the subject locally; "Advantages of the Junior College,"" and "A Study in Methodology," are cross-sections of certain phases of educational work; "Recovery of Vanadium," a contribution from one of our outstate members, is timely when certain individuals are attempting to befog rather than to point out the process of determination of rare metals, Vanadium and others; "The Two Species of Bunt," is a contribution of unusual importance. The other articles are none the less valuable by reason of not being specially mentioned and will be of interest to the readers who are engaged in the pursuits indicated or for the more general interest which students entertain.

It is not required that members contribute only through the papers read at regular meetings, but it will add to the value of publication if Northwest Science becomes the forum for presentation of data of interest to members and others; if scientific, informative, or inquirative, to advance the personal or collective interest in or knowledge of Science.

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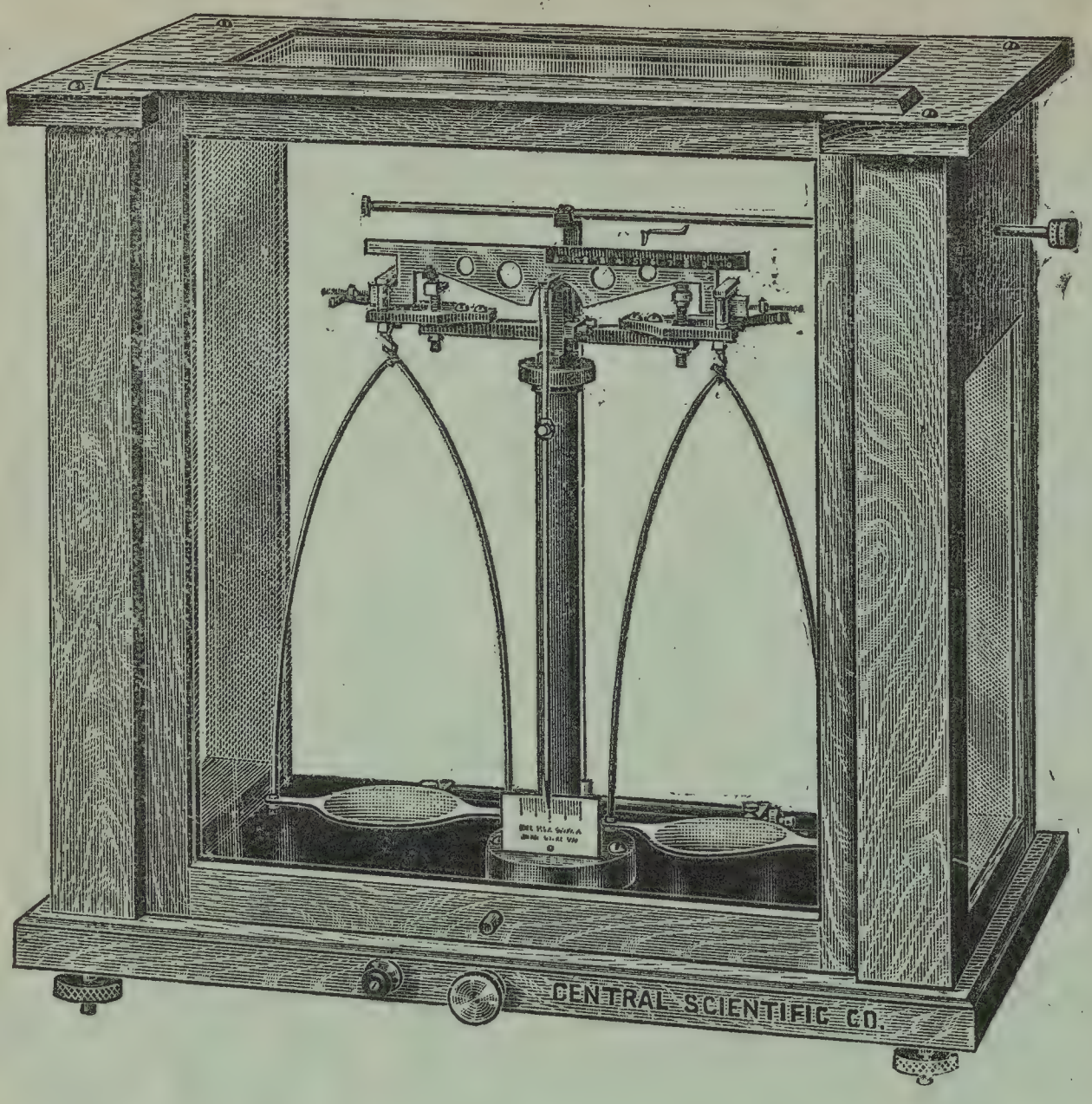

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NORTHWEST SCIENCE

VOL. III SEPTEMBER, 1929 NO. 3

REVALUATION OF THE DIRECT PRIMARY*

CHESTER C. MAXEY

Miles Moore, Professor of Political Science, Whitman College.

The sign manual of science is the question mark. The scientific mind recognizes no eternal verities. It fears nothing, reveres nothing, stops at nothing. Only a few short years ago the dogmas of democracy were believed to be bottomed upon the solid rock of obvious and imperishable truth. Popular government was government "of the people, by the people, and for the people". What could be more plausible or more simple? The will of the people was supreme; public opinion was the will of the people energized and canalized into an active force; elections were processes whereby this force was transformed into definite and concrete results. Defects in the elective process might, to be sure, prevent a realization of the true will of the people; but if these defects could be overcome by the introduction of perfected and fool-proof systems of election, which was not an unreasonable expectation, no sane person could doubt the certain advent of a golden age of justice, equality, brotherhood, and reason. *Vox populi, vox Dei.*

It was a beautiful and inspiring theory, this Lincolnian doctrine of popular government, and was never doubted by right-minded persons. God was in His Heaven, and His long-suffering children, now happily emancipated from the shackles of despotism and oppression, would surely provide for the well-being of the world. But the scientific mind refused to be hypnotized by ecstatic visions and rapturous prophecies. With an eye for facts only, the phychologist, the anthropologist, the sociologist, and the political scientist continued their exploration of the deep recesses of individual and social behavior, and soon produced a body of data which compels us to cast into discard many of the ancient and honorable dogmas of democratic thought.

The findings of Dewey, Beard, Watson, Sumner, Giddings, Allport, Bentley, Wallas, Lippman, Laski, Lowie, and a host of other valiant souls who have dared to pry into the secrets of human conduct leave no doubt about the error of the rhapsodical assumptions underlying the structure of modern political democracy. It is clear now that James Madison was right, and wise beyond his generation, when he wrote in Number Ten of *The Federalist* that the people *en masse* do not and cannot move spontaneously and universally to a common conclusion or to the execution of a common purpose. there is no such thing as collective intelligence or collective will self-mobilized and directed toward preconceived ends. Only tiny groups of people are capable of concerting together so as to reach a common conclusion or accomplish a common task. Large groups or masses of people are scarcely more than inert, though fluid, aggregations of particles. Like the waters of the sea, they are without volition or capacity for self-propulsion, but may be deeply agitated and stirred to violent action by the excitation of external forces. The simile fails, however, in two particulars. The dynamics of a sea of human beings differ from those of a body of inanimate particles in these respects: (1) In a mass composed of human beings the stimuli which set the mass in motion may, and frequently do, originate in the

*A paper prepared for the Annual meeting of the Northwest Scientifie Association, Spokane, Wash., Dec. 28, 1927.

behavior of individuals who are themselves particles of the mass; and (2) in in a mass composed of human beings, since the individual particles of the mass do possess the power of volition and of self-directed action, it is possible for the particles as individuals, acting in response to stimuli affecting the mass, to choose a course of action which will be determined by the nature of the stimuli and of the response mechanisms upon which they operate. These two peculiarities of the social aggregate are responsible in the main for the prevalent illusion that the people can and do think and act as a self-impelling collectivity. Careful observation and analysis of social and political processes, based upon a most impressive accumulation of psychological data, demonstrate that this is not and cannot be true; and that Mr. Lippman is right when he says that the "public" in the old sense of the term is a phantom and that "public opinion" is an illusion.

If these conclusions are correct—and they are now accepted by the most eminent and authoritive students of social and political psychology—we are compelled to abandon the venerable platitudes of democracy; and should devote ourselves to a critical appraisal and revaluation of the institutions of democratic society in the light of modern scientific knowledge. It is in this spirit and with this purpose that I offer here a few observations on the subject of the direct primary.

A detached observer surveying the American scene at the beginning of the present century would have noticed little evidence of an impending popular upheaval. The country had just been completely and gloriously saved from the diabolic dangers of bimetallism. After some years of dallying with strange heresies in the field of tariff legislation, the true faith had been restored by the enactment of the memorable Dingley Bill. Memories of the distressful days of '93 were being gradually dimmed by the advancing tide of prosperity, and the hum of industry was heard throughout the land. The bitter acerbities of sectionalism had been dissipated by the patriotic ecstacies incident to the Spanish War, and politicians no longer found profit in waving the "bloody shirt". The acquisition of an overseas empire had disclosed the "manifest destiny" of the United States, and millions of humble and hard-working citizens were intoxicated with dreams of imperial grandeur. With the saintly McKinley in the White House the great drama of national politics moved forward with solemnity and serenity, though offstage, concealed in the wings and eagerly awaiting the cue to play his turbulent part, the Rough Rider chafed in restless restraint. Everywhere the prospect was fair as a summer day—and similarly pregnant with cyclonic possibilities.

Beneath the surface of things, however, all was not well with the favored children of the western world. The democracy which they so proudly proclaimed to the world was beginning to exhibit what Mr. E. L. Godkin had described as "unforeseen tendencies", but which more caustic observers labelled as unqualified failures. Publicists, poets, preachers, plutocrats, plebeians—persons of every kind and kidney—in abject prostration kowtowed at the shrine of popular sovereignty: yet there was scarcely a clod-pated yokel in the land who did not entertain a suspicion that the whole business was a gigantic fraud, for in the dim background of the holy altar it was possible to discern the figures of Murphy, Gorman, Hanna, Platt, Quay, Penrose, and other high priests of the cult of Beelzebub. Nominally sovereign and supreme, the people were slowly becoming conscious of the fact that they were little more than passive spectators at a carnival of humbuggery and knavery.

Although public officials of every rank from poundmaster to president were elected by popular vote, the people in reality could only choose between lists of candidates nominated by partizan methods. The independent candidate had little chance

against candidates backed by the organized power of political parties. The government of the country had fallen into the hands of organized party machines that made mockery of democracy and justified the worst fears of Washington and other immortals of the patristic age who had labored mightily to found a government that would be proof against the machinations of party. The basis of party control was the nominating system. Nominations were made by party conventions whose motivating impulses were supposed to reach back to the rank and file of the party acting in and through the primary caucus. Theoretically the voice of each member of the party found expression in the primary caucus of his voting district. This caucus was an assembly of all of the members of the party within that area for the purpose of determining party tactics and selecting candidates for local offices. In the caucus were selected delegates to county or municipal conventions which made nominations for offices in the county or city, and in turn chose delegates to district or state conventions. The district or state conventions made nominations for district or states offices, and in their turn chose delegates to the national nominating convention of the party. If the rank and file of the party were in control at the bottom—namely, in the primary caucus—their influence might well extend through each series of conventions to the national nominating convention, which was the apex of the system. But it seldom happened that way. It was fairly easy for practised politicians to manipulate the caucus so as to have their own way regardless of the sentiments of the rank and file; and when they failed in this, the succeeding conventions afforded a perfect ambush for conspiracies against the popular interest. Party processes readily succumbed, therefore, to the domination of machines, rings, and bosses. Inert, powerless to act collectively on their own initiative, the people could only swallow their wrath and watch while graft, iobbery, corruption, and venality ran rampant through the land. Popular indignation was enormous, but smouldered and seethed beneath the surface because there was no channel through which it might act to destroy the hated system. Reformers attacked the convention system and proposed various expedients in the way of remedial tinkering, which upon adoption proved to be of no value.

Such was the state of things when the crusade for the direct primary began. Originally put into operation by party rule as a means of making local nominations, the direct primary system crashed into the political arena as a national issue in 1903 when the state of Wisconsin, under the redoubtable leadership of the late Robert M. La Follette, swept aside the convention system and introduced the direct primary on a statewide basis. The impact of this event was quickly felt in every portion of the Union. The appeal of the direct primary was irresistible, and the arguments for it plausible and compelling. It was a reform the people could understand, and in which they did not hesitate to put their trust. Political leaders of progressive inclinations adopted the direct primary as one of the first articles of their creed—sponsored legislation for its adoption—and the people flocked to their standards. The mass was in motion at last, and was doing the only thing that people in the mass can do, namely, taking an affirmative or a negative stand on questions brought before them by the initiative of the few. And it was really the individuals in the mass who were doing this, not the mass as a whole. But the movement had the appearance of almost spontaneous mass action, because of the pent-up wrath that had been accumulating for upwards of a century was released all at once and flowed irresistibly in the direction of the direct primary. Within a decade fully half of the states had adopted the direct primary in some form, and by the end of the first quarter of the century only three states—Connecticut, Rhode Island, and New Mexico—had

failed to join the procession. Repeated efforts were made also, though without success, to secure the enactment of a national primary law which would dispense with the convention system in the nomination of candidates for president and vice-president of the United States.

The theory of the direct primary was as simple as it was seductive. Assuming the existence of an all-prudent and omnicompetent public, capable on its own motion of conceiving and initiating actions, it was plain as a pikestaff that the business of making nominations should be placed directly in the hands of the rank and file of the party. That being done, the infallible commonalty of each party would nominate candidates representative of their ideals and aspirations; and the discriminating public at the general elections would then pick from the party slates the candidates most likely to serve and promote the welfare of all the people. Granting these premises, no logician could possible dispute the conclusions. Better men would undoubtedly be nominated—men loyal to popular interest and not beholden to bosses, machines, or party organizations. Men of eminence and ability would be more willing to enter the lists and run for office, because under the direct primary system they would have a fair chance to win on their merits. Conspiracies against the common weal would be discouraged, if not altogether thwarted, because of the apparent difficulty of manipulating a direct primary election as the old caucus and convention had been juggled and maneuvered. The cold white light of publicity would pitilessly play upon every step of the nominating process, thus insuring intelligent popular action, stimulating popular interest, and guaranteeing popular sovereignty.

Intoxication, it is said, produces many strange illusions. We should remember, however, that there is always a "morning after" which produces equally numerous and equally weird illusions. We have passed through a night of buoyant intoxication with the direct primary and are now sunk in the disconsolate pessimism of the morning after. And in the enthusiasm of our remorse we are bent on imagining things about last night's jamboree which are not as bad as they seem to the penitent eye. The truth is bad enough without any exaggeration. The direct primary has certainly failed to live up to its advance notices. It has not banished the boss and the pettifogging politician. It has not eliminated corruption and venality. It has not produced candidates free of blemish or stain. It has not destroyed the power of money in politics. And it *has* developed certain faults which were not evident in the caucus-convention system which it supplanted.

It was a great mistake ever to regard the direct primary as a panacea; but it is equally erroneous to stigmatize it as nothing but a nostrum. Not all of the entries belong on the debit side of the ledger. If we condemn the direct primary on account of the prodigious sums expended in the nomination of such persons as Newberry, Smith, and Vare, we should commend it for the absolutely negligible sums in securing the nomination of such men as Frazier, Nye, Brookhart, Ashhurst, and Greene. If we find fault with the direct primary for putting "Jim" and "Ma" Ferguson in the State House, we should give it credit for promptly turning them out—a thing that could not so easily be accomplished by a spoils-swayed convention. If we denounce the direct primary on account of the light vote cast in primary elections and the frequency of minority nominations, we should not fail to remember the heavy vote and the decisive results of primary elections in which there have been real issues and candidates who stood for or against something in which the people were vitally interested. If we object to the direct primary because at times it seems to militate against party unity and solidarity, we should not forget the frequent rifts in the party front caused by intra-convention warfare and the many occasions when a popular can-

didate nominated by the direct primary has rescued his party from fore-doomed defeat. The trouble with most of the present-day discussion of the direct primary is its insistance upon painting a picture in arbitrary blacks and whites, whereas truth is nearly always gray.

But the middle-of-the-road thinking, though it may be scientifically correct, has little or no place in the realm of political controversy. In politics one must be dogmatically for or against a thing. The political scientist, if forced thus to align himself in one camp or the other, can take only one position with reference to the direct primary. He must be emphatically for it. Every person who has a grasp on political realities knows that the dirrect primary is no longer a theory, but an obstinate fact. There are persons who profess the conviction that the faults of the primary will ultimately force us back to the convention system, but they are self-deluded positivists who are engaged in the popular indoor pastime of allowing the wish to father the thought. Moses was able to lead the Children of Israel through the wilderness to the Promised Land; but though the Promised Land soon developed an unexpected shortage of milk and honey, there was no Moses who could march the unhappy people back to the wilderness. That was a thing of the past. It is even so with the convention system. It is water over the wheel and can never come back. Even though the defects of the direct primary should outnumber those of the convention system by 10 to 1 (and the true of that), there could be no turning back. You can induce the people to vote power into their own hands; but the demagogue never lived who could persuade the people knowingly to take a step that would look like voting power out of their own hands.

Let us assume, however, that it may be possible to flimflam the people into a repudiation of the direct primary. What then? Back to the convention system? No institution in the whole range of American political experience is so thoroughly discredited as the convention system. The most sordid scandals ever disclosed in the political life of any people are associated with the convention system in this country; and although we have been tinkering with it for upwards of a century, there is little hope that its fundamental defects can ever be cured. What wisdom is there in sacrificing an institution that we feel to be bad for one that we know to be worse? Could any people be stupid enough to commit such folly?

But if, on abandoning the direct primary, we seek some alternative other than the convention system, what else is there? Nothing has been definitely proposed except a hybridization of the primary and convention systems by adding to the primary system a pre-primary or post-primary convention for the purpose of adopting a party platform, deciding party tactics, and, if desired, placing in the field a list of candidates specifically blessed by the party organization. Several states, particularly South Dakota, Colorado, and Minnesota, have experimented with this idea without obtaining conspicuously better results than are to be had by the use of the primary system or the convention system singly. As a matter of fact it is difficult to see how either a pre-primary convention or the post-primary convention can do much to strengthen the primary system. A convention held before the primary election is likely to be a purely tentative affair, and often degenerates into a disgraceful scramble among the various candidates and their adherents to line things up for the forthcoming primary race. A convention held after the primary election admirably serves the purpose of a post-mortem, and that is about all. Its deliberations can have little influence upon candidates already approved by the vote of the rank and file of the party, and it is likely to do little more than furnish an opportunity for defeated and disgruntled candidates to vent their spleen upon the nomin-

ees. Another proposal, which has the distinction of being advanced by Mr. Charles E. Hughes, is that the controlling committees of the party, which in his opinion should be chosen directly by the members of the party, should have authority to prepare and submit to the party at the primaries a list of candidates who in their judgment could best represent the party. Other candidates could be brought forward by the usual process of petition. The members of the party would then have an opportunity to choose between the "organization" slate and any other candidates who might appeal to them. The "Hughes Plan", as it is called, has not been taken up seriously by either the friends or the foes of the direct primary, and there seems to be little chance of its ever being adopted. Apparently nobody trusts party committees, not even party committee-men themselves.

In view of the evident lack of a feasible or acceptable substitute for the direct primary, it is not difficult to understand why the direct primary is so successfully weathering the storm. A leaky roof is better than none at all, and there is always a possibility of stopping the leaks. No one will seriously contend that the direct primary is perfect, or that there is much chance of its being made perfect; but it is seemingly better than anything we can hope to get in its place. It is also true that the improvement of the direct primary is not a hopeless matter. If, for example, we could reduce the number and frequency of elections and materially cut down the number of candidates to be considered at a given election, a great many of the infirmities of the direct primary would vanish like snow before the balmy breath of the "chinook". The election system of this country, because of the multiplicity of elections and candidates, imposes upon the voter a burden which would overtax the discrimination and intelligence of a race of supermen. It is no wonder the direct primary sometimes fails; the wonder is that it has even partially succeeded. That there are abuses, serious ones too, connected with the direct primary, no one can deny. But a great many of these abuses can be checked, if not as have recently been witnessed in Michigan, Illinois, and Pennsylvania. Many men have been sent to prison for much less serious offenses against society than those perpetrated by Newberry, Vare, Smith, and their political associates; and when we reach the point where we are ready to apply to the man who steals a nomination the same criminal penalties that we do to a man who steals property, we shall hear much less of the follies of the direct primary. Infinitely more helpful, however, than putting teeth into our primary laws would be the results of putting character into our political parties. The political parties of today are empty bottles, distinguishable from one another only by the faint surviving odors of what they once contained. Give us parties that have character and stand for real principles, and the direct primary will mirror the virtues of the party as faithfully as it now mirrors the vices.

But from the standpoint of the scientific investigator all questions of reform and improvement in the direct primary system are somewhat beside the mark. The real crux of the case from the scientific point of view is whether the direct primary, even if perfected, is inherently the sort of process that democratic society can employ with success. Taking as granted the postulates of the modern social psychologist that collective mind, collective will, and collective action exist only in imagination; and that what we conceive as mass phenomena are in reality nothing more than the multiplied and aggregated responses of myriads of individuals to the complex stimuli which originate in modern social conditions—taking these things for granted, is there any reason to believe that the direct primary is a better medium for the effectuation of the socially expressed individual will than is the convention system?

I think there is.

The modern conception of political society compels us to recognize that man as a political animal, when he acts as a member of a group, is limited to precisely two ways of reacting to political stimuli. He can say yes or no, accept or reject, enlist for or against a given cause. Individuals can initiate things, but masses of individuals can only take positive or negative action with reference to things initiated by individuals. As Mr. Walter Lippmann puts it in his notable book entitled *The Phantom Public*: "The public does not select the candidate, write the platform, outline the policy any more than it builds the automobile or acts the play. It aligns itself for or against somebody who has offered himself, has made a promise, has produced a play, is selling an automobile. The action of a group as a group is the mobilization of the force it possesses.'

The last sentence is particularly significant. "The action of a group as a group is the mobilization of the force it possesses". If this be true, superior political processes, from the standpoint of their service to democracy, are those which facilitate the mobilization of the force of the group as a group. The few are the *pro*posers always; but in democracy the many should be, and in the end must be, the *dis*posers. Any system of procedure that reverses this relationship, or that limits the ability of the many to mobilize their full force as final disposers of the issues raised by the actions of the few, is not a sound procedure for a democracy.

Judged by this criterion the convention system rates far below the direct primary. The convention system makes popular control depend upon the ability of the many to organize their force and assume the initiative in seizing and maintaining the upper hand in a labyrinthine series of caucuses and conventions. It is as though an army were required to plan the strategy of a battle and maneuver itself through the various evolutions necessary to carry on the fight. No one would expect an army to be able to do such a thing, and by the same token no one should expect the rank and file of a political party to be able to maneuver itself through the intricacies of caucus and convention procedure.

The direct primary imposes no such absurd and impossible task upon the many. Under the direct primary the many are constituted a court of last resort to which the few must appeal for the final disposition of matters initiated by the few. This makes it possible for each individual in the group consisting the many to take positive or negative action as an individual with reference to the issues which have been brought before the high court of public opinion for final settlement. By this means multitudes of individuals are enabled to focalize their wills upon one definite result, and thus really to exert power as a group. The result may not represent the absolute preference of the individuals composing the group, or it may, but it does nevertheless represent a decision with the mobilized power of the group behind it, and a decision which has to be made because of a concrete issue which has arisen in the arena of political action. Whether the results be good, bad, or indifferent, such procedure is thoroughly and fundamentally democratic because the final disposition of the issue is a matter of individual determination in response to social stimuli. No such result ever has or ever can come from the convention system.

In conclusion I would enter a caveat to the effect that the direct primary should not be regarded as a final achievement, but simply as a phase of the evolution of democracy in America. Democracy is not an end, but a way. For that reason democracy and institutions of democracy are forever on the make. The direct primary represents one chapter in this story of endless change; but it may be that the experience derived from the direct primary will teach us to make the next chapter more nearly perfect.

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REED COL., PORTLAND
COLUMBIA U., PORTLAND
PACIFIC COL., NEWBERG
LINFIELD COL., McMINNVILLE
INDUSTRIAL SCHOOL FOR GIRLS
SCH. FOR BLIND, DEAF, FEEBLE MINDED
OREGON NORMAL SCH., MONMOUTH
PACIFIC U., FOREST GROVE
PORTLAND
COLUMBIA RIVER
SNAKE RIVER
BALMON RIVER
COLL. OF IDAHO
CALDWELL
BOISE
GOODING COL.
GOODING
ALBION NORMAL
ALBION
POCATELLO
U. OF IDAHO
SO. BRANCH
RICKS COLLEGE
REXBURG
BIG HORN RIVER
POWDER RIVER
North Platte River
125°
120°
115°
110°
105°
45°
50°

MAP OF EDUCATIONAL INSTITUTIONS IN PACIFIC NORTHWEST*

*Squares are State Supported. Rounds are Independent or Sectarian.

The map indicating the location and character of educational institutions in the two southwestern provinces of Canada and four northwestern U. S. states is a contribution of Dr. Francis A. Thompson, president of Montana School of Mines, but errors of location or name are chargeable to the Editor. Anyone discovering an error will kindly report it to the end that when all data have been proven errors will be corrected and a second issue of the map be reproduced in this magazine.

Following is a segregated list of the institutions shown, as representing the character, so far as reported.

Province or State	Public	Independent or Sectarian	Total Reported
Alberta	1	7	8
British Columbia	1	1	2
Idaho	4	3	7
Montana	5	2	7
Oregon	6	13	19
Washington	5	8	13

These institutions constitute a group of college or university grade and could commedably cooperate in the upbuilding of a strong educational and scientific activity in the Pacific Northwest. Members of the Northwest Scientific Association hope to be called on to aid in accomplishing such a desirable result and the members and others who may be interested in such an undertaking are cordially invited to lend their support to the proposed program.

Through the generosity of Dr. J. R. Hobbins, vice-president of the Anaconda Copper Company, the Montana State School of Mines has received the donaion of six acres of land adjoining property of the school in Butte. The gift was fittingly accepted by President Francis A. Thomson.

SLASH DISPOSAL IN IDAHO*

ELDON H. MYRICK
Supervisor St. Joe National Forest

The need of leaving cut-over areas free from slash as a necessary aid to protection was recognized by the men responsible for drawing up the present Idaho Forest Law, and is probably the greatest obstacle to be overcome in furthering forest perpetuation in Idaho.

There is no need of going into the history regarding the criticism that sprang up from all sources when notice was served that the law must be complied with. Some logging operations evaded its intent by broadcast burning their slash, while fires mysteriously occurred on other areas leaving the same result—a blackened waste upon which all tree growth, not previously logged, was killed; and a fine setting left for an even more intense fire sometimes in the future.

The law became unpopular with the average citizen who favored conservation and forest perpetuation, since his interpretation of its application was the broadcast examples before his eyes.

Its unpopularity with some timbermen, who as a mass favored the idea, was based on the high cost in disposing of slash by the pile and burn method. Some made a conscientious effort to do so at a cost of from eighty cents to one dollar per thousand feet of logs removed. All of these had more or less experience in seeing that investment a loss by the area broad-casting when the piles were burned.

The result in 1926 was a general let up in even trying to comply and in the spring of 1927 it appeared very evident that some drastic measures would have to be taken, if the whole law was not to become a farce.

Investigation showed that there had been no organized effort to educate loggers for this work; such as, when to burn and when not to burn, and how to

*Presented at the Meeting of the Northwest Scientific Association Spokane, Wash., Dec. 27-28, 1929.

secure the maximum protection at the minimum cost—incidently a cost they would be willing to pay and could really afford. In the spring of 1927 The State Forester and Timber Protective Associations cooperated by having special men make a survey of the slash conditions, advising the loggers how to do the work, and enforcing the law, and was repeated in 1928.

One of the needs was a concrete study of methods and actual demonstration in order that the logger would have a measuring stick upon which to gauge his disposal work.

The Forest Service was intensely interested in proving the practicability of slash disposal on private holdings, having practiced it for years on all their timber sales and being convinced that it was necessary if future stands were to be grown, and welcomed a chance to put on a large-scale-demonstration of its practical application. The Winton Lumber Company offered the disposal of their slash on Emerald Creek, within the St. Joe National Forest, to us, and after looking over the area it was taken over at forty cents per M. ft. B.M. log scale and Seventy cents per hundred linear feet for all cedar poles removed from the area.

No special provisions as to methods were made; the Government agreeing only to do as much as possible for the price and endeavor to work out a satisfactory method that would meet with the State Foresters approval. In laying out the work, two factors were kept in mind, namely:

1. That slash disposal was not necessary to secure reproduction.

2. That it was primarily a fire preventative measure.

It was also evident that a 100% pile and burn would be impossible, for the price agreed to, so the work was laid out so as to secure the greatest protection. Large blocks of undisposed slash were broken up, the heavy slash and that of high hazard being carefully piled and burned, and blocks of scattered slash of low hazard, along ridge tops or damp bottoms, rarely over a few acres in extent, were left intact.

A large delegation of lumbermen examined the work done in the fall of 1927 and a very optimistic attitude resulted. They left the area feeling that slash disposal, at a reasonable cost, was possible and a good investment, and were encouraged by the State Forester's approval of the job. Some lumbermen started work of the same nature on their operations but others were still reluctant to spend a cent not required to log the timber.

In studying the situation as a whole this fall, it was found that a considerably larger amount of slash had been disposed of during the past season and it is believed the field demonstration, more than any one other factor, is responsible for it.

The situation is, however, far from what it should be. A majority of the slash is still being undisposed of, or is being broadcast burned. It is evident that the work of putting over slash disposal has hardly begun and greater progress in securing voluntary conformance by the responsible logger, and public support to aid in enforcing the other, must be made if the chief payroll of Northern Idaho is to be perpetuated.

It will require a combination of several factors to make the necessary progress, and leadership of the best to coordinate the work to be done.

Following are a few of the major data and work that is now in need:

1. Continued education of the public and logger that disposal is necessary for protection and perpetual Forest Production.

2. Research and actual demonstration to determine what is adequate disposal on different types and stands.

3. Organization and cost analysis data.

4. Study of cut-over areas, growth

expectation, values and carrying costs, in order to determine on what character of stands disposal is financially justifiable.

5. Research to determine most economic kind of equipment needed to carry on the work.

6. Coordination of all factors to keep the law in force and elastic enough to provide for any changes in methods of disposal found to be good practice.

7. Providing ways and means to assure uniform conformance with the law by all operators.

8. Education of the public as to the economic value of continued forest growth on forest lands.

The Emerald Creek job was just an example of the many that should be undertaken by the industry and I am glad to say that several others are being worked on.

It might also be of interest to here briefly summarize the work done on the Emerald Creek job to date:

Total acreage cut-over, to date—2,785 acres.

Total cut for same acreage exclusive—69,000 M ft. B.M. of improvement timber.

Total linear feet of Cedar poles removed and slash disposed of—441,225.

Total piling and burning—62,000 ft. B.M.

Total slash not piled and burned—7,000 ft. B.M.

Total area upon which slash was left—1,045 acres.

Total percent of slash left on cut-over area of 1045 acres—10.3%.

Total percent of slash piled and burned on Total cut of 69,000,000 ft, Lot scale—89.7%.

Total percent of area on which slash has been disposed of—63%.

Total percent of Area upon which slash was left—37%.

The average cut per acre where slash was left is approximately 7 M ft. B.M. and where the slash was disposed of is 41 M ft. B.M. per acre with an average stand per acre of approximately 26 M ft. B.M., exclusive of the Cedar Poles.

This does not take into consideration the slash from timber cut for chutes and other improvements and is not final, as the job will not be completed until next spring.

In burning the slash less than 15 acres was broadcast and an examination of the disposal done a year ago showed that practically no green trees had been killed although approximately 15 M ft. B.M. per acre of mixed species is being left uncut.

This job is not being held up as an ideal for I am convinced still further betterments can be made. It does, however, prove that a reduction in cost is possible without greatly increasing the fire hazard and that it can be burned without killing the timber left uncut.

A group of cereal chemists have formed the Association of Pacific Northwest Cereal Chemists with a membership of twenty-four from Idaho, Montana, Oregon and Washington, with the following officers: President, J. W. Montzheimer, Seattle; Vice-President, Jos. Drumheller, Spokane; Secretary-Treasurer, T. R. James, Spokane. The members will not content themselves with purely scientific problems, but will seek remedies for legal defections, also simplify and unify practice.

Dr. Harold St. John, department of botany, State Collegge of Washington, has resigned to accept a position as head of the department of botany, University of Hawaii and Dr. Harry F. Clements. graduate of the University of Wisconsin followed the conferring of the degree of doctor of philosophy by the Univer- most interesting geologic features.

HISTORIC SPOTS IN THE SPOKANE COUNTRY*

W. D. VINCENT
President Old National Bank & Union Trust Company, Spokane, Wash.

The Spokane region is rich in historic incident, and there are many historic spots that should be marked that their locations might be preserved for future generations and so marked as to convey the correct information concerning the history of that particular locality. The first white men to touch the borders of the Spokane country were Lewis and Clark and the men of their expedition, and the first monument is a stone cairn built on the Clearwater River near Ahsahka, Idaho. The Lewis and Clark expedition, returning from the mouth of the Columbia, again camped on the Clearwater, and on May 6, 1806, they met some Indians that belonged to the tribe named Skeetshomish, living at the place we now call Spokane Falls. There are only a few monuments on the Lewis and Clark trail, and Spokane people should eventually become interested in placing a monument at the Clearwater camp where Lewis and Clark met the first Spokanes.

In August 1810, John Jacob Astor sent the ship Tonquin from New York to the mouth of the Columbia River, arriving at what is now Astoria on April 12, 1811. With the Astorians was Alexander Ross and Gabriel Franchere, in "Franchere's Narrative" tells of meeting two Spokane Indians who had come from Spokane House to deliver a message to the whites at the mouth of "The Big River" Spokane House had been established for a number of months prior to the establishment of Astoria and had been built by Finnan MacDonald and Jacques Rafael Finlay, members of Thompson's Northwest Co. employees. Spokane House, established by the Northwest Company in 1810, was located just above the forks of the Spokane River and its junction with the Little Spokane River. With the exception of a small boulder placed there by the Boy Scouts, there is no monument or marking of any kind to indicate this remarkable historic romantic and important location.

David Thompson was the greatest land geographer of the English speaking people and did much for the early development of this part of the country. Thompson Falls in Montana and Thompson River in British Columbia are the only two important geographic places bearing his name. I had occasion to visit Montreal some years ago and found it necessary to make a talk setting forth some of the interesting things of the Northwest. I mentioned the importance of David Thompson and his activities to the development of the Pacific Northwest and that he was buried in an unmarked grave in the city of Montreal. The Montreal men were evidently startled by the statement, and whether or not the statement had anything to do with the result, a monument was afterwards placed at the grave of David Thompson and the host of the evening to whom I had made the statement was the man who unveiled the monument of England's great geographer.

Thompson's memory should be preserved, and it would be much more fitting that a monument be erected in Spokane to him than almost anyone else that could be named.

About the time of the establishment of Spokane House, an Indian child was born, son of the Chief Illm Spokanee, from whom the name Spokane was derived. This child as a boy was sent to Fort Garry, now Winnipeg, and received an education in English and French, and came back to the Spokane country and his people. From his return until his death, he was most influential in many of

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the historic things connected with the development of this region.

David Douglas, from which the Douglas fir was named, visited Spokane House after its abandonment by the Hudson's Bay Company, travelled on to Fort Garry, where he saw Chief Garry, and in his journal gives many things that would justify the erection of a monument or tablet to his memory.

In 1835 the Reverend Samuel Parker visited the Spokane country, going up to what was then Fort Colville and holding the first Christian religious services near Springdale. No doubt this point could be ascertained and a monument erected near Springdale.

Twenty years ago a monument was placed at Walker's Prairie to mark the efforts of Walker and Eells in their missionary work at the Shimoken Mission. A monument stands to memorialize the work of Father DeSmet at the old mission building on the Couer d'Alene River. It is to be hoped that it will be many years before decay or fire destroy it, but an added indication of our respect for his importance in our history should be built near the old mission.

Governor Isaac I Stevens came into the country from the East in 1853. Several camps were made in the states of Idaho and Washington, but the important camp was located at the forks of Coulee Creek, nineteen miles northwest of Spokane. Governor Stevens went to the Hudson's Bay Post at Fort Colville, where he met Captain George B. McClellan and returned with him to Camp Washington.

Twenty years ago the Washington Historical Society placed a monument at what they supposed to be the site of Camp Washington. Many of the residents of that locality who have travelled the old Colville-Walla Walla road knew that the camp had been at the forks of Coulee Creek, but they could not persuade the authorities to make any change in the placing of the monument, which was six miles from the actual camp site. Last October, in company with the owner of much of the land in that locality, Mr. John H. Williams, I went to the forks of Coulee Creek, saw the old Colville-Walla Walla Trail, found the exact location of the crossing of the Hite-Coulee Road and had the monument moved from the old site to the crossing of the Colville-Walla Walla road. A bronze tablet was placed on the monument to indicate its location as being about three-fourths of a mile northwest of the site of the camp.

With Governor Stevens was Captain Mullan, who advocated and afterwards built the Mullan military road from Fort Walla Walla on the Columbia to Fort Benton on the Missouri. A number of monuments are placed along this military road in its course through Montana and Idaho, and a few have been placed on the road in the state of Washington. There are other points where monuments should be placed on this great highway of the early days.

Probably the most important highway of that period was from Fort Walla Walla to Fort Colville, two Hudson's Bay Posts. David Thompson in making his return trip from Astoria came up the Snake River to the mouth of the Palouse and in his "Journal", August 6, 1811, says: "At the *road* was a village of fifty men with their families". This road was the Indian trail which leads from Walla Walla to Colville.

John Clark of the Astorians travelled over the same trail when he came to establish the post for the Pacific Fur Company in its competition with the Spokane House Post of the Northwest Company. The Reverend Samuel Parker travelled over the Colville-Walla Walla Road. Governor Stevens made his trip from Colville and with his command from Camp Washington to Walla Walla over the old Colville Road.

One monument has been placed on this old road where it intersects the Sunset Highway about two and one-half miles west of Deep Creek. The importance of placing a monument where it is visible is probably greater than to have the monument on the actual site. This can be illustrated by the monument erected by the Daughters of the American Revolution at the Steptoe battlefield at Rosalia. The monument is something very much to the credit of the patriotic organization, but its value to the public would be greater if the monument could be removed and placed only a few yards from where it is to the side of the highway where thousands would see it where only a few now know of its existence.

The Colonel George Wright campaign following the Steptoe defeat commenced with the battle at Four Lakes, which is not marked, then to the battle of Spokane Plains, where a pyramid of basaltic rock has been placed by the Great Northern Railway where it crosses the Sunset Highway. Colonel Wright's troops then followed down the river back to Fort Wright and made their camp either on the parade ground at Fort Wright or near the river, where water was more accessible. The exact spot is not important, but the Daughters of the American Revolution have placed a monument near the parade ground at Fort George Wright.

Horsekill or Horseslaughter Camp, where Colonel Wright's troops destroyed nearly nine hundred of the Indians' horses, should have a marking of some kind, not to commemorate such destruction, but such destruction brought about the closing of the campaign which ended at Smyth's Ford on Hangman Creek, between the whites and Indians in 1858. A monument was placed over the grave of Chief Garry in Greenwood Cemetary by the Spokane Garry Chapter of the Daughters of the American Revolution, and its epitaph follows:

"GARRY

Chief of the Spokanes
His life spanned the
unfolding of the Spokane Country from the
days of fur traders at
Spokane House to the
activities of a modern
city."

There has come to hand, through the courtesy of someone to whom we are much indebted, a copy of the "First Anniversity Edition of 'MONTANA WILD LIFE' official Publication of the Montana State Fish and Game Department", being Vol. 2, No. 1 of that periodical. Indicative of the intelligence of the Commissioners is the fact that they have invited the scientists of the University of Montana to contribute of their knowledge of the different phases of wild life, which has been responded to by Dr. Melvin A. Brannon, Chancellor, in a paper entitled "Cooperation Between the Commission and Scientists of the State University; by Dr. C. H. Clapp, President of the University in a contribution on "Flathead Lake—Millions of Dewdrops"; by Dr. M. J. Elrod on "The Fishes of Flathead Lake"; by Dr. R. T. Young on "The Zoology of Flathead Lake"; a report by Dr. Young on work done by the late Dr. J. E. Kirkwood on the Botany of Flathead Lake; by Prof. G. D. Shallenberger on "The Physics of Flathead Lake"; and by Prof. J. W. Howard on "The Chemistry of Flathead Lake". These several contributions form a symposium on the region in and about Flathead Lake commendable in its conception and of great scientific value in its application. A reprint of this work for public libraries and High school use in the State would enhance its permanent value.

APPLICATION OF POLARIZED LIGHT TO METALLOGRAPHY*

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PURPOSE

The purpose of the work described herein was to try the affect of vertically incident, plane polarized light upon specimens of metals. Apparent anisotropism was observed in some of the specimens, and an explanation is suggested. The work was done under the direction of Professor S. H. Graf, Department of Mechanics & Materials, at Oregon State College, the writer being assisted by H. R. Vinyard, a graduate student in the Department of Physics.

EQUIPMENT

The equipment consisted of a standard Leitz microscope fitted with a vertical illuminator which held the polarizing nicol. The microscope was mounted on a metallographic stand. A carbon arc was used for illumination, the light being reflected by two concave mirrors thru an iris diaphram into the vertical illuminator. A glass prism reflected the polarized light to the specimen, and a cap nicol was used for an analyzer. The magnification was 100x.

PREPARATION AND EXAMINATION

A piece of electrolytic copper (U. S. Bureau of Standards) about 5/8 inch square was deformed under a 33,000 pound load to about 65% of its original thickness. A portion of the deformed specimen was annealed at 950 degrees C (1742 degrees F) for one half hour The annealed, unannealed, and unde-

Figure 1. Alpha Copper, 100 X, etched with acid ferric chloride, with parallel nicols.

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formed specimens were polished for examination.

Alpha copper which has been strained and annealed develops twinned crystals the size of these crystals seemingly dependent on the intensity of the strain and the annealing temperature.

Examination of the specimens showed that they were composed of alpha copper. ary illumination. When the nicols were crossed, portions of the surface were light while adjacent areas were dark, instead of the entire field maintaining the same degree of darkness, as would be expected from work in petrography. Then the entire field would attain almost its maximum degree of brightness and maintain it until the nicol had been rotated near-

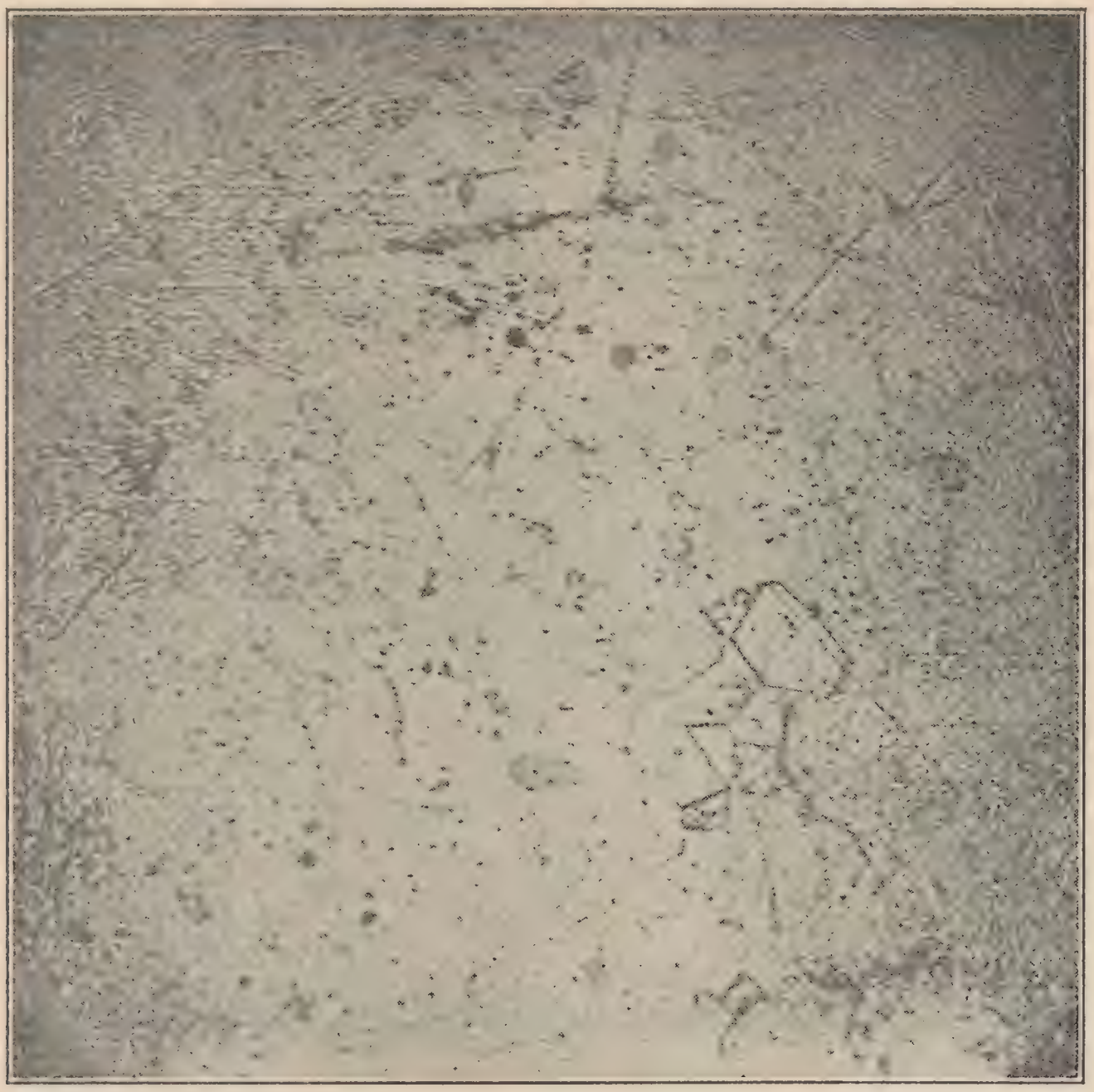

Figure 2. Same area and same conditions as in Fig. 1, except that the nicols were crossed. The alternate light and dark areas are portions of twinned alpha copper crystals.

The undeformed specimen showed a few Neumann lines, and it was concluded that the strains set up in the electrolytically deposited copper caused the twinning. The deformed but unannealed specimen showed more Neumann lines than the undeformed specimen. The deformed and annealed specimen showed large twinned crystals, and this specimen was used for further examination.

Vertically incident, plane polarized light with parallel nicols showed no features which were not observed by ordinly 180 degrees. The area of darkness occurred within an area of 5 degrees at the 180 degree point.

Figures 1 and 2 are interesting as micrographs of the same area, Figure 1 being taken with parallel nicols and Figure 2 with crossed nicols. The particular portion of the specimen used showed practically no structure under parallel nicols and was used to show the maximum effect of crossed nicols. The specimen was not disturbed during the taking of the micrographs so conditions were iden-

tical except for the position of the cap nicol. It will be noted that Figure 1 shows practically no structure with the exception of a few grain boundaries. Figure 2 shows how crossed nicols help bring out the twinning structure in a more pronounced manner than parallel nicols or ordinary illumination. As a rule, however, suggestions of the twinning structure could be seen with parallel nicols, crossed nicols making the effect more pronounced.

Etching is Necessary

To determine the effect of etching on the specimen, the area shown in Figures 1 and 2 was marked, the specimen repolished to remove all the effects of etching and then examined. With parallel nicols no structure was observed. With crossed nicols the entire field became dark at the same point, at every 180 degree revolution. This was directly contrary to the effect noted with crossed nicols on the etched specimens. The conclusion is that etching is necessary before polarized light can be affected by the twinned crystals. This is an important point which will be considered under the theory of the effect of the polarized light on the specimens.

Examination of Steel and Lead Antimony Specimens

The effect of polarized light was tried on various other specimens to secure more data on the results. Specimens of steel were chosen to represent hypo-eutectoid, eutectoid, and hyper-eutectoid steel. These specimens showed the three components, ferrite, cemetite, and pearlite in each specimen, and one specimen showed sorbite.

Pearlite consists of tiny alternate plates of ferrite and cemetite, and at 100x, appearing much like an ordinary fingerprint. The softer ferrite is probably worn away a trifle deeper than the cementite, causing this fingerprint appearance. Sorbite is pearlite which has been broken up by heat treating into tiny dots of ferrite and cemetite.

Unetched, these specimens showed no effect with crossed nicols, as was expected from the work with alpha copper. In all cases, with crossed nicols, the specimens etched, ferrite and cementite were dark. Pearlite, however, showed apparent anisotropism, as areas of great brightness, suffering wavy extinction thru a 5 degree angle. As in the copper specimens, further rotation of the cap nicol caused the entire surface to remain at the same degree of illumination until the 180 degree point was reached, when the features above mentioned were again observed.

Various lead-antimony alloys were examined and all the components extinguished at the same time under crossed nicols. The lead-antimony eutectic does not develop a lamellar structure as does pearlite.

It was interesting to note that deep scratches and the boundaries of deeply etched grains showed as bright lines under crossed nicols, and extinguished in the same manner as twinned alpha copper, pearlite and sorbite. A short treatment of the theory of polarized light will be necessary before interpretation of the data.

Wright (1) has presented an article concerning the theory of the effect of polarized light on ores and metals. Briefly, the effects are caused by the optical characters and orientation of the grains, by thin surface films, by grinding striae giving the effect of grating polarization, or by reflection from oblique surfaces.

In this experiment the optical orientation of the specimens seems to be relatively unimportant, as unetched specimens showed no effect, while the same specimen, etched, showed in part marked anisotropism. If the optical character of the grains had any effect on polarized light, such effect should have been noticeable in the unetched specimens.

1. Wright, F. E. A study of Ores and Metals, Proc. Am. Phil. Soc., Vol. 58, 1919, p. 442.

Thin surface films are considered unimportant in this investigation, for altho the isotropic grains frequently had marked tarnish films, anisotropic effects were not observed.

Grinding striae should have been as marked on unetched as on etched specimens and yet no effect was observed.

Reflection from oblique surfaces appears to be the most important factor. All the components which showed apparent anisotropism has oblique surfaces. The oblique surfaces of the copper twins were readily detected. Pearlite consists of alternate laminae of easily etched ferrite and resistent cemetite, which on etching develops oblique surfaces. Sorbite behaves in a similar manner. Deep scratches and the boundaries of deeply etched grains obviously have oblique surfaces.

According to Wright, reflection of plane polarized light from oblique surfaces caused a slight rotation of the plane of polarization, which would give the effect of anisotropism. Such was found to be the case with the specimens studied.

The conclusion is that when etching of a metallographic specimen develops oblique surfaces, the plane of the polarized light is slightly rotated and an apparent effect of anisotropism results.

The results, as far as metallography is concerned are disappointing. No definite criteria, as in petrography, were observed; the result being to intensify existing criteria rather than indicate new. Unresolvable pearlite and sorbite might be identified by this method, however. The highly polished mirror-like surface of the opaque metal probably reflects such a large portion of the light that the optical characteristics and orientation of the grains cannot rotate enough of the polarized light to be obserable. The writer hopes to continue the study with polished rock specimens in an endeavor to ascertain any favorable data.

COLLOIDAL PROPERTIES OF WILLIAMETTE VALLEY SOILS*

R. E. Stephenson

Soils Dept. Oregon State College Experiment Station

Seven representative soil series, Chehalis Fine Sandy Loam, Cove Clay, Willamette Silty Clay Loam, Dayton Silty Clay Loam, Aiken Clay Loam, Olympic Clay, and Melbourne Silty Clay Loam, were selected for study of their colloidal properties.

The first two soils are recent alluvial formations, the second two are old terraces now above overflow and the last three are residual hill formations. One of the hill soils, Melbourne, is from sandstone, while the other two are from basalt.

The Dayton series is difficult to farm because of a heavy clay subsoil, and the Cove is likewise difficult to farm because of uniformly heavy texture. The other soils are rather desirable agricultural lands.

The soils were all sampled in the field by horizons so that surface soil (A horizon), subsoil (B horizon), and parent soil farming material (C horizon), could be studied and compared independently.

The colloid material was separated from the three horizons of one soil, the Chehalis, and studies and comparisons were made with the whole soil.

The amount of colloid was determined for the different horizons of all the soils. The methods of the bureau of soils (1) (2) were used. Both the colloidal material of the one series and the

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1. Gile, P. L. et al., 1924. Estimation of Colloidal Material in Soils by Absorption., U. S. D. A., Bul. 1193.

2. Robinson, W. O., 1922. The Absorption of Water Vapor by Soil Colloids. Jr. Phys. Chem. 26:647-658.

whole soils of all the series were analyzed for Al_2O_3, Fe_2O_3, SiO_2, and CaO, to compare composition with properites. The exchangeable calcium, and reaction were also studied. Likewise the retention of one anion, the PO_4 ion was studied for both the colloidal material and the whole soils.

The amount of colloid found varied from about 20 per cent to 65 per cent. The general tendency was for the subsoil to run higher in colloidal material than the surface, due to the removal from the surface and deposition in the subsoil by percolating waters. In one series, the Willamette, there was practically the same amount of colloid in both surface and subsoil. The concentration of colloidal material in the subsoil horizon is a characteristic of a maturely developed soil profile.

It is quite noticeable, however, that there is more colloid in the parent material than in either surface or subsoil, indicating either a horizontal difference in profile due to natural deposition or a removal of colloid and loss into the drainage from both surface and subsoil, with the surface soil subjected to greater loss. Such loss does not preclude a concurrent concentration of colloid in the subsoil by removal from the surface, however.

Study of the colloidal material shows that it is higher in organic matter, alumina, and iron, but lower in silica, and lime that the whole soil. These results check favorably with those obtained by the Bureau of Soils (3) except that lime is usually higher in the colloid than in the whole soil.

Bennett (4) in studying humid-tropical and humid-temperate soils placed them in two general groups according to physical characteristics and chemical properties. In one group he placed the friable, nonplastic lateritic soils. For this group he found a low molecular ratio of ratio for 24 soils was 1.25. In the oth- Al_2O_3 -|- Fe_2O_3 to SiO_2. The average er group was placed the plastic non-friable soils. The ratio for this group averaged 3.71. The ratio 2 was selected arbitrarily as the dividing line between the two groups. These ratios should not be taken, however, as simply arbitrary divisions, but as indicating the general tendencies of the two groups of soils.

The soils of this study were found to fall decidedly in the plastic, non-friable group. Only two soils indicated a slight lateritic tendency, the Aiken and the Olympic. The average ratio for Al_2O_3 -|- Fe_2O_3 to silica in the surface soils was found to be 3.88. The Aiken soil dropped to 2.38 and the Olympic to 2.59. The Aiken series is known locally as a red hill soil due to its red color, though analysis shows slightly less iron than in the Olympic, which is a rich brown color..

Though the data are too meager for definite conclusions the indications are that true laterites have not found in this section of the country, but local areas are somewhat lateritic in nature. A true laterite soil has been rather thoroughly leached of its bases, and is weathered to great depth. The friable and porous structure may extend to several feet in tropical laterite soils. The slight lateritic tendency found in this section probably does not extend to more than a very few feet at most.

A study of the reaction of these soils shows, that none are very acid. The pH varies from about 5.0 to 6.0. The calcium in exchangeable form varies from about one-sixth of one per cent in Aiken to half of one per cent in the Olympic series. The per cent of the total calcium which is in exchangeable form varies from 8.00 in the Chehalis to more

3. Robinson, W. O. and Holmes, R. S., 1924. The Chemical Composition of Soil Colloids., U. S. D. A., Bul. 1311.

4. Bennett, H. H., 1926, Some Comparisons of the Properties of Humid-Tropical and Humid-Temperate American soils; with special reference to Indicated Relations Between Chemical Compositions and Physical Properties. Soil Sci. 21:5:349-374.

than 50.00 in the Melbourne series.

The colloidal material of the Chehalis series contains nearly one per cent of exchangeable calcium and more than 90 per cent of the total is in exchangeable form. These data corroborate the general belief that the available calcium is held by the colloidal material. On this basis the Aiken soil, which showed somewhat lateritic tendencies, should be most in need of liming. This characteristic is manifest in exactly the opposite way, however, in other soil which seemed somewhat lateritic. The Olympic soil has the highest per cent of exchangeable calcium, and should, therefore, be less in need of liming than some of the non-lateritic soils.

It is the general belief, and probably true that lime tends to preserve the colloidal exchange complex from breaking down, and would thus tend to prevent lateritization. However, the rate at which this complex breaks down after the calcium is removed seems to be rather uncertain. Some of the soils which appear to resemble laterites most, have a high exchange capacity. Likewise highly acid soils, show a high exchange capacity, apparently about as high a capacity as those which have been better supplied with lime and maintained nearer neutrality. In fact, it is the high exchange capacity of acid soils, in part at least, which gives them their high acidity.

That the colloidal material of soils retains large amounts of the cations, in readily reactive form is well established. The manner in which available anions are held on the other hand is not so well understood.

Of the anions the PO_4 ion is retained in larger quantities than any other. It appears that the colloidal material is rather intimately connected with the retention of this ion. It was found that at the lower concentrations, retentions of PO_4 from neutral mixtures of monopotassium and disodium phosphates was nearly complete. The colloidal material retained as high as 5600 P. P. M. of PO_4 from solutions containing 12,800 P. P. M. at which point the colloidal material appears to have been approaching its maximum capacity.

Retention of PO_4 by the whole soils was not as complete even at the lower concentrations as by the colloidal materials. Different soils show considerable variation, and the correlation of phosphate retention with amount of colloid in the soil is not close. The maximum retention by any soil was only about three-fifths that of the colloidal material Maximum retention of the whole soil for Chehalis series was only about two-fifths that of the separate colloid.

Though it has been commonly thought that phosphate, so retained, is held as an insoluble precipate, indications here do not substantiate this view. Assuming that all the exchangeable calcium functions to precepitate phosphate, only about one-third the amount retained could be accounted for. After liberal allowance for precipitation by soluable aluminum and iron there is still much unaccounted for. It seems probable that some considerable phosphate may have been retained by some physical action as well as by precipitation.

It may safely be stated that by whatever action phosphate may be retained applications of large amounts of soluable phosphate fertilizers may safely be made to soils well supplied with colloidal material, without fear of excessive losses.

Dr. R. J. Holden, professor of Geology, Virginia Polytechnic Institute headed a party of about twenty, the personnel of which was made up largely of students and faculty members of the same institution, with a few geologists from other sections and institutions passed through Montana, Idaho, Washington and Oregon late in July, viewing the most interesting eological features.

IDAHO PLAN OF CONSOLIDATING STATE ADMINISTRATION FUNCTIONS*

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In analyzing the position that Idaho occupies among the forty-eight states with respect to the reorganizing of her executive department, a brief summary will first be given of the causes leading up to this movement. The administrative functions of our state governments have been increasing very rapidly the past quarter of a century with the result that numerous boards and commissions have been created. During the first decade of the twentieth century provision was made for approximately 1500 new boards and commissions among the forty-eight states. In 1913 the legislatures of thirty-five states added 236 administrative organizations and in 1915, 175. While the number of administrative agencies in the various states has fluctuated from year to year surveys show that Delaware had 117 in 1918, Illinois 130 in 1917, New York 187 and Massachusetts 216 in 1919.

A great many factors have contributed towards this increase of state administrative boards and commissions. In some cases the motive has been merely to provide salaried jobs for loyal party workers. This, of course, is never openly acknowledged but when a needless and ntterly useless commission is created with functions duplicating an existing organization the act is undoubtedly an attempt to subscribe to the theory of partisan politics practiced so extensively a few generations ago, namely "To the victor belongs the spoils". Again, these boards are created at times by the legislature for the express purpose of delaying final action on some issue of state wide importance. If both houses are about evenly divided on an important matter in dispute an easy way of escaping responsibility is to create a new board giving it authority to determine the policy of the state in regard to the issue at hand.

But in the great majority of cases these new agencies for administrative work have been created through honest motives on the part of the legislators and have been necessary for specialized study of particular problems. The functions of the state have been expanded in recent years to include such fields as the promotion of agriculture along scientific lines, the dispensation of charity among the dependent classes of society and the regulation of such business organizations as banks and railways. Along with this extension of governmental functions has developed the need for new organizations to seek and digest data and in many cases to apply technical knowledge and skill to these specialized problems.

The result of this development has been the creation of a vast number of boards and commissions, covering in detail the activities of the state as they deal with the affairs of every day life. These administrative organizations possess delegated authority from the state and are now exercising jurisdiction over a wide field including such matters as public utilities, sanatation, and health problems; charity, defectiveness, and delinquency; the regulation of women and children in Industry; the regulation and licensing of various callings and professions; equalization of taxes; control over the state's military forces; the betterment of rural conditions; the promotion of agriculture; the conservation and development of forests, mines and water power; and the construction and maintenance of canals, parks and highways.

What then are the objections to a system of state administration carrying a large number of boards and commissions? One of the main defects is the lack of

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uniformity in organization within a given state. Almost every conceivable method of selecting the personnel of an administrative board is found. For example, the state of New York had 187 administrative boards or commissions in 1919. Of this number seven were chosen by popular election, fifteen were appointed by the Governor, seven were appointed by the legislature, fourteen were ex-officio bodies, seventeen were determined by a combination plan, some of them being ex-officio members, others being appointed by the Governor, sixty-eight were appointed by the Governor with the approval of the Senate and the remaining fifty-nine were selected in a mixed number of ways.

Other defects include matters pertaining to tenure, compensation, removal, duplication, expense and lack of coordinating authority. Some of these boards within a state have a fixed term while others have an indefinite tenure. Likewise with regard to compensation, the members of certain commissions enjoy a definite fixed salary, others are paid on the fee plan and still others receive no compensation whatever for their services but are allowed merely expenses incurred in the performance of their official duties.

The removal of incompentent members can as a rule be accomplished only through impeachment proceedings. Another weakness of the decentralized system of state administration is the frequent duplication of a given state function. For example, Illinois prior to 1917 had separate boards for each penitentiary and reformatory. There were six boards dealing with the agricultural interests of the state and about twenty with labor and mining interests. The laws of Illinois at that time required that industrial accidents be reported to several state offices. In most states the administrative boards operated independently of each other without any uniform system of accounting or responsible budgeting plan. There was likewise no unifying or coordinating authority among these administrative agencies. The result of such a system with its duplication and overlapping functions is not only confusion and added expense but general inefficiency and a total lack of fixed responsibility.

What are the essentials for an effective reorganization of these administrative functions of state government? Briefly stated, these include not only the grouping of related functions under the same department but an internal organization of each department separated into divisions and bureaus with an appointive head fully responsible for the work of his section. They include the abolition of unnecessary offices and the consolidation of duplicate activities into a few coordinated departments. The heads of these departments should be appointed by the Governor and responsible to him. They should have a tenure of office coinciding with his term and they should in fact serve as the Governor's cabinet. Such a plan would secure unity, efficiency and economy in the executive department of our state governments.

As a matter of fact, no state has been able thus far to comply whole heartedly with this test due to the limitations upon the power of the legislature. A complete reorganization would require an amendment to the Constitution in almost every state with the exception of New York. Unsuccessful attempts to bring about reorganization in the executive departments were made in Oregon in 1909, Minnesota in 1913 and New York in 1915.

Idaho was one of the pioneers in this movement for the consolidation of state administrative functions. The present plan, known as the cabinet government in Idaho went into effect in 1919 and had been preceded only by the Illinois revision of 1917.

Under the Idaho plan fifty-one separate and independent bureaus, boards and commissions were abolished and their func-

tions taken over by nine departments as follows: Agriculture, Commerce and Industry, Finance, Immigration and Statistics, Law Enforcement, Public Investments, Public Welfare, Public Works and Reclamation. In 1921 the Department of Commerce and Industry was merged with the Department of Finance and in 1923 the Department of Immigration, Labor and Statistics was tentatively abolished as the legislature failed to make an appropriation for the same.

As a result, Idaho now has seven Departments instead of nine as originally planned. The heads of these departments are called Commissioners. They are appointed by the Governor and are directly responsible to him. In addition, the Governor appoints certain officers within the departments, each officer being responsible to the respective commissioner to which he is assigned. These departmental officers are as follows: In the Department of Agriculture—Director of Markets, Director of Animal Industry, Director of Plant Industry, Director of Fairs; in the Department of Finance—Director of Insurance, Manager of State Industrial Insurance; in the Department of Law Enforcement—the Fish and Game Warden; in the Department of Public Welfare, the Public Health Advisor; in the Department of Public Works, the Director of Highways; in the Department of Reclamation, the Director of Water Resources.

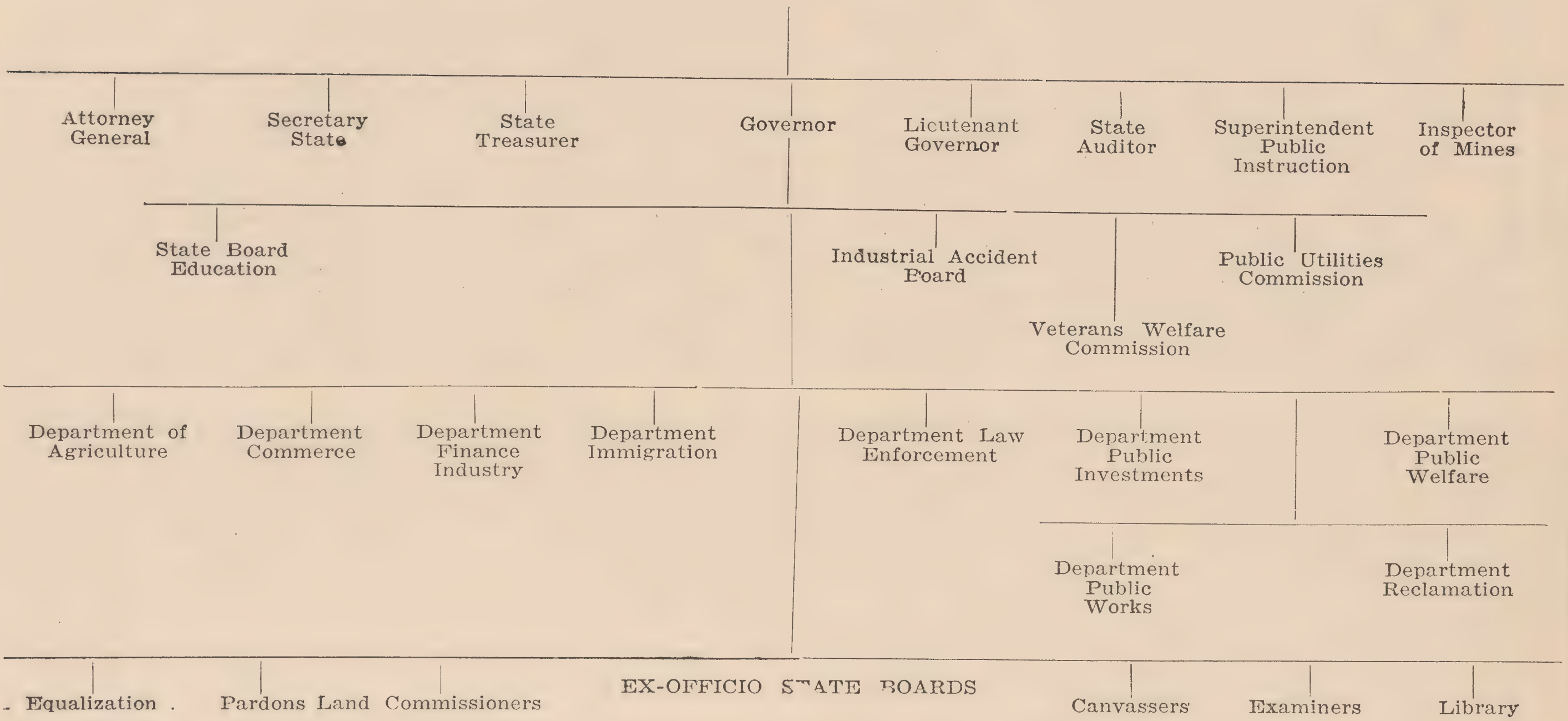
Some of these Departments are divided into bureaus. For example, the Department of Agriculture has the Bureau of Animal Industry, the Bureau of Plant Industry and the Bureau of Weights and Measures. The Department of Finance consists of five Bureaus as follows: Banking, Insurance, Industrial Accident Compensation, Liquidation and Blue Sky. The Bureau of Child Hygiene and the Bureau of Vital Statistics are a part of the Department of Public Welfare while the Bureau of Highways, the Bureau of Construction and the Bureau of Supplies are within the Department of Public Works.

Idaho has the following ex-efficio Boards and Commissions: (1) State Board of Equalization composed of the Governor, Secretary of State, State Treasurer, Attorney General and State Auditor, (2) State Board of Pardons composed of the Governor, Secretary of State, and Attorney General, (3) State Board of Land Commissioners—Governor, Secretary of State, Attorney General, State Auditor, Superintendent of Public Instruction, (4) State Board of Canvassers—Governor, Secretary of State, State Treasurer, Attorney General and State Auditor, (5) State Board of Examiners—Governor, Secretary of State, Attorney General, (6) State Library Commission—Attorney General, Secretary of State, Superintendent of Public Instruction and President of the State University.

Idaho has a few boards and commissions in addition to the ex-officio organizations. They are as follows: the Reclamation District Bond Commission, the Public Utilities Commission, the Industrial Accident Board, the Bureau of Public Accounts, the Bureau of Budget and the Veterans Welfare Commission. In the main these Board and Commissions are under the control of the Governor. For example, the Reclamation District Bond Commission consists of the Commissioner of Reclamation, the Commissioner of Finance and the State Land Commissioner. The Public Utilities Commission consists of three members appointed by the Governor. Four of the five members of the Veterans Welfare Commission are appointed by the Governor. The Bureau of Public Accounts and the Bureau of Budgets are directly responsible to the Governor although they work in conjunction with the auditor's office.

An outstanding example of the Idaho plan of control as applied to the few

IDAHO



Note: 1921 Legislature transferred Department of Commerce and Industry to Department of Finance.

1923 Legislature made no appropriations for Department of Immigration Labor and Statistics.

The Veterans Welfare Commission was created in 1921.

boards and commissions not included within the seven administrative departments is the State Cooperative Board of Forestry. In 1925 the Legislature created the Forestry Department of the state government to be headed by a state forester who in turn is appointed by a cooperative forestry board of twelve members. The members of this board are the Governor, Secretary of State, State Auditor, State Superintendent of Public Instruction, State Land Commissioner, the Dean of the School of Forestry of the University of Idaho, the Commissioner of Reclamation and four citizens of the state appointed by the Governor as follows: one on the recommendation of the Timber Protective Association of South Idaho, one on the recommendation of the Timber Protective Association of North Idaho, one on the recommendation of the Idaho Wool Growers' Association and the Idaho Cattle and Horse Growers' Association and one on the recommendation of the United States Service.

The Idaho plan of consolidating state administrative functions is very obviously one that concentrates broad administrative powers in the hands of the Executive and places upon him a very definite responsibility for the carrying out of these functions. It is in harmony with the Idaho plan of education adopted in 1913 which provides for a unified control of all schools of the state. The law providing for this consolidation expressly states that the Governor shall devise a practical and working basis for cooperation and coordination of the work of the departments. An example of this has been the appointment of the Secretary of State as the Commissioner of Law Enforcement. The Governors serving under the Cabinet Plan in Idaho have taken a serious and conscientious attitude not only towards the principles of the new law but the spirit of the law as well.

The question is frequently asked why Idaho continues to elect her state officials,—that is why this new plan was not still more far reaching in the way of executive control. Like most of the states that have taken steps in this direction, Idaho went about as far as possible without amending the state Constitution

What then is the present status of the Idaho Cabinet system as compared with the movements for reorganization that have occurred the past decade? In 1919 Nebraska and Massachusetts also reorganized their executive departments and were allowed in 1921 by Ohio. Of these three, Ohio had the most thorough plan of reorganization but each of them followed the general principles of reorganization used by Illinois and Idaho. In every instance the principle of concentrated authority and fixed responsibility was adhered to within the maximum limit permitted by the state constitution.

In 1923, the leadership in this movement was won by Tennessee. Not limited by constitutional restrictions as in most states, the sponsors of the plan for consolidating state administrative functions were able to concentrate tremendous power in the Executive. With the exception of the Railway and Public Utility Board, the Governor is the only administrative official elected by the people. The Secretary of State, Comptroller and Treasurer are appointed by the Legislature. All other state officials are appointed by the Governor and may be removed by him at will.

In 1923 Pennsylvania, Vermont and Maryland passed laws providing for a reorganization of their respective state administrative departments but in none of them was the effect so far reaching as in Tennessee. The Pennsylvania plan brought 105 agencies together under fourteen departments and three commissions. Twenty boards were left undisturbed and only twenty agencies were actually abolished. In some matters the boards and commissions within the department have powers independent of the

head of the department and with the exception of finance the system requires but little if any genuine supervision of department heads. Under the Vermont plan only twenty boards and commissions were actually abolished. The Maryland plan also abolished only a few agencies and as a rule new ones were created to take the place of the ones discontinued. These three plans like that of California in 1921 consist more in a rearrangement of the existing system than in a complete reorganization.

In 1925 Minnesota adopted a reorganized plan for her state administrative functions, comparing in a general way with that of Idaho and Illinois. The same year New York ratifying a constitutional amendment providing for a plan of state administration reorganization. A State Reorganization Committee was appointed with Charles Evan Hughes as chairman, to draw up plans for this new program. The report completed in March 1926 provides for the consolidation of 180 bureaus, boards and commissions into 16 departments. It makes the governor responsible for the budget and gives him broad powers in the way of appointments and removal. The new plan went into effect in 1927 and New York now has concentrated even greater administrative control in its Governor than that allotted by Tennessee in 1923.

Proposed plans covering reorganization of state administrative functions have within the past few years been made in Oregon, Iowa, New Jersey, Colorado, Virginia, North Carolina, Delaware, Connecticut, Michigan, Missouri, Arizona, Arkansas, South Dakota, Kentucky, Nevada, Oklahoma, Indiana, Texas and Wisconsin.

COMPARATIVE EFFICIENCY OF AUTOMATIC COAL STOKERS FOR DOMESTIC HEATING*

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The coals which are available for domestic use in the Northwest carry a fixed carbon content ranging from 38% to 48% and a volatile matter of 30% to 47%, approximately. In the customary method of hand firing a domestic furnace through a firing door which is above the level of the top of the fire. Of necessity in this type of firing the green coal is deposited more or less on top of the hot coals of the fire. Immediately there sets in the usual coking and distilling process which drives off the volotile matter in the green coal. Owing to the fact that the top of the fire is more or less covered by the new coal, there will be an appreciable length of time when there is not sufficient heat in the upper part of the fire-box to completely burn this volatile matter and it is therefore lost up the chimney in the form of dense smoke. Furthermore, the passage of these products of incomplete combustion through the furnace results in the deposit of a layer of soot on the furnace walls.

The heat insulating qualities of soot compare very favorably with many other very high grade heat insulators. For instance, the heat conductivity of asbestos paper is .0006, of magnesia .00045, of sawdust .00012, and of lamp black, or soot of .00007. From the foregoing it will be seen that soot will transmit approximately one-ninth as much heat as will the same thickness of asbestos paper.

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No one, for instance, would consider lining his furnace with asbestos paper.

Briefly then, the operation of the hand fired furnace wastes a tremendous gas which also sets about to insulate the walls of the furnace most effectively so that only part of the heat from the coal actually burned can be transferred to the rooms of the house.

The underfeed principle of firing coal, which, by the way, cannot be accomplished with a coal shovel, largely eliminates the two objections cited above. The coal is introduced into the coolest part of the coal bed, namely, the bottom, leaving the combustion chamber uncooled either by cold green coal, or by cold air entering the open firing door. Furthermore, the gradual heating of the coal in the bottom of the fire gradually distills the volatile matter which undergoes more or less complete combustion on its passage up through the hot coal bed. As a result, the valuable volatile constituent of the coal is not lost but is burned and furthermore, the furnace walls are not so thoroughly and effectively coated with heat-insulating soot. Consequently, more BTU's per pound of coal burned will find their way into the living rooms in the case of the underfed furnace, than in the case of the usual hand fired furnace.

The Engineering Experiment Station of the State College of Washington, has undertaken the study of the efficiency of the underfeed firing of domestic furnaces as accomplished by means of several different automatic underfeed stokers. Six different stoker installations are being studied, including both hot air and hot water sytems. Records are being kept of the temperatures maintained in the houses, of the outside temperatures, of the amount of coal used by each per day, and of the amount of ash removed. The latter is always in the form of clinker. Studies are being made of the actual transfer of heat into the water of the heating system per pound of coal burned by the automatic underfeed firing as compared with hand firing.

It is granted as regards health that there is a recognized desirability of having a uniformly heated house. It is desired in the study, to determine the average efficiency in maintaining a uniformly heated house which may be expected from the coal when burned by an underfeed stoker as compared with the usual hand firing method. Furthermore, it is expected that a comparison will be made of the value of different coals for use in underfeed type of domestic stokers.

It is expected that the results of these tests will be available for publication early next summer.

APPLICATION OF SCIENCE TO CONCRETE MANUFACTURE

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Contrary to popular belief, there has been a real romance written during the past few decades, in the development of concrete as a building material. During forty years we have seen concrete emerge from a class of material whose properties were but little known and the manipulation of which lead to uncertain results, to one of the most versatile of all building materials. As a rule the layman has accepted this growth and improvement with hardly a thought as to its origin, and yet in that time the cement industry has grown from a few scattered kilns and burr mills to one of the twenty leading manufactures in the United States.

During the first quarter of a century of its existence as a commercial product in this country, Portland Cement re-

ceived much attention and improvement in its manufacture, until a uniform product was generally manufactured thruout the country, but it was not until recent years that a study of the other constituents of concrete has been made. It is of this latter phase of concrete making that this paper will largely deal.

Concrete is more than a more or less homogeneous mixture of cement, sand, gravel and water, poured into forms or as slabs—this will give an indifferent mass incorrectly called concrete. But if this mass is to really become concrete, that is artificial stone, it must at least approach some of the characteristics of stone, it must have a fairly high compressive strength, must withstand abrasion and be more or less impervious to the action of water. It was the attaining of these qualities that led to a study of the factors entering into the constituents of concrete other than cement.

For something over ten years the Lewis Institute, now the Structural Material Research Laboratories, carried on a series of experiments involving some quarter of a million tests. Among the many useful facts discovered through these researches, two stand out significant, The Fineness Modulus, and the Water-Cement-Ratio. The evolution of these theories mark the most revolutionary step in the history of building material, since the introduction of the Bessemer process in steel manufacture. For years it has been recognized that there existed a relationship between the grading of aggregate and the strength of the concrete obtained. This relationship has been crystalized in the Fineness Modulus, which is a grading factor expressed in such a manner that it can readily be introduced into equations and computations. The Water-Cement-Ratio theory expresses a direct relationship between the amount of mixing water and the strength of the concrete, for a fixed cement content; in other words the strength of the resulting concrete will be higher with less water and lower with more water if all the other ingredients remain fixed.

The next step is to transfer these scientific data into dollars and cents, when that can be done, then the contractor and builder will listen to the theory and not until then.

Let us take a practical field example where these ideas have been put to a real test. During the construction of a hydroelectric development involving the placing of 125,000 cubic yards of concrete, modern laboratory methods modified to meet field conditions were put into practice and proved, not only workable but economical. Workable in that they furnished concrete of a uniform quality that could be easily handled, and economical by furnishing a concrete of a uniform strength at a minimum cost. The matter of workability will only be touched on in passing. Through the use of the "Inundator" the variation in the quantity of mixing water was reduced to a minimum. This coupled with other improved batching equipment eliminated guess work from the making of concrete.

The question most often raised is, "Is it economical to bring the fine haired theories of the laboratory into the field? Isn't the old 1:2:4 sloppy mix best after all?—and has not nature laid down natural pits with material just about as it should be?" The answer to the first question is "yes" and to the last two "no". The location of the project under consideration is at the junction of two glacial morains and the problem of aggregate was one more of elimination than of selection, for sand and some form of gravel is found almost anywhere in the project area. Nearly all practical, available sources were sampled. The samples thus gathered were subjected to a Mechanical Analysis, then Fineness Mo-

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duli were determined, the percentage of gravel and sand determined, mixes designed and the amount of material to be wasted, calculated. This process brought out the fact that the two most suitable sites were quite different in location and composition. One—a river bar of well graded material would have required a long haul up a steep grade to make it a workable location for a central screening and washing plant. The other gravel bank was situated more centrally but the material was inferior to that of the river bar. A series of Mechanical Analyses indicated that the gravel bar would be more economical for screening and washing a large quantity of aggregate as the waste would be negligible. The long haul was just about off set by the more elaborate conveying equipment required to place the product in the bunkers. In this case the laboratory data was the deciding factor from the standpoint of economy. The screening sizes were determined from Mechanical Analysis and were of such sizes as to give concrete of maximum strength and density with a minimum quantity of cement. Constant check throughout the construction was made to see that aggregates furnished were up to standard, and the resulting concrete was subjected to regular tests for compressive strength at periods of seven and twenty-eight days. In fact scientific methods were applied to practically every phase of the concreting operations. An example will suffice to show how these methods often meet the practical more than half way. Through the seven day compressive strength and the workability test, known as slump test, over-speed in one of the mixers was discovered and corrected with an accompanying gain of approximately 750 lbs. per square inch at 28 days and a very much improved mix.

The application of scientific methods to concrete manufacture on this job netted an actual saving in cement amounting to nearly two hundred thousand dollars beside giving a concrete of remarkable uniformity. When looked at from this angle it is seen that it really does pay and pay big both in dollars and cents and in the satisfaction of producing a high grade product.

There is nothing mysterious nor very complicated about the scientific design and control of concrete mixture. The process does not become so involved as to become burdensome; however, there are a few rules to which close adherence is absolutely necessary, otherwise the method admits of considerable latitude in its application. First, the water cement ratio law must be recognized; second, a consistant technique must be developed. This technique need not be elaborate any more than the field laboratory equipment need be extensive, but it must be such that it will give consistent results.

Assuming that the preliminary investigations and studies have been made, the laboratory routine and the field control on a project which warrants the installation of a fairly well equipped laboratory are about as follows: A mechanical analysis on a set of Tyler Standard Sieves is made of both coarse and fine aggregates and from the percentages retained on each sieve the Fineness Modulus of each is calculated. From this same sample but before it is dried secure the weight of a unit quantity in its native state, that is damp and loose, this is the condition of the material as it leaves the stock piles. Next find the moisture content of the aggregates either by drying to constant weight or by the displacement method, with the moisture displacement cylinder. The latter method is much quicker, more accurate and gives very consistent results, but requires an additional piece of apparatus. From these dried samples determine the unit weights of the aggregate, that is dry rodded, this is the condition of the material as it is in the mixer. It will be readily seen that there is considerable difference

between the volume of the same sample in these two conditions. It is to correct for this change in volume that these analyses are made. Other data that should be secured at this time are, voids by the volumetric method, colorimetric reaction for organic impurities in the sand and determination of the specific gravity of both coarse and fine aggregate. With these data any one of the three principal elements of concrete may be determined provided two of them are known, i.e. if you know what mix is to be used and what degree of workability is desired, the strength may be calculated from the above data, or if you are working to a predetermined strength and workability, the mix may be worked out by the application of the data given. Other information to be obtained from the foregoing studies are the yield per sack of cement and the quantities of material per yard of mixed concrete for a given mix or a pre-determined strength.

To check this work and control the mix in the field requires definite data on the concrete actually placed and this is only obtained by making test specimens, simulating as nearly as possible in their cure, the job condition. These specimens are tested. Testing usually is carried out at seven and twenty-eight day periods and specimens are tested to destruction in a standard compressive machine. The standards set up by the A. S. T. M. will give the most consistent results and are not burdensome in their application.

As noted above, a consistent technique is absolutely necessary if good results are to be obtained, that is develop a technique that will give you the results sought and then stick to it. This is especially true in sampling materials and in making specimens for compressive tests. It is a good rule to have your samples too large rather than too small, you can always reduce a sample by the quartering method. Be sure the sample is representive of the whole body of material to be covered by the tests. Stock piles tend to classify themselves, that is, as material is dumped on them, the heavy or coarse aggregate roll to the foot of the pile and the finer sizes are trapped in the top or crown of the pile, it is therefore very essential that a sample be taken from a number of places in the stock pile and a composite sample made up and reduced to convenient size when ready to be analyzed. In making up compressive test specimens follow the A.S.T.M. standards as closely as possible, especially regarding tamping the wet concrete in the molds, it is here that greater variation will occur than at any other step in the work. A series of tests on the above mentioned project, disclose a difference of 2800 pounds per square inch in compressive strength at age of 28 days, where the specimen was under-tamped and over-tamped. More satisfactory results will be obtained if specimens are given their final capping in the field and this cap allowed to set up with the specimen, rather than bedding the specimen in the testing machines when ready to break it. Keep full and accurate records of all laboratory and field work. Printed forms to suit the work in hand are best as they tend to keep one doing the same thing, the same way, but whether printed or not be sure that all pertinent data are recorded.

Briefly summarized, the steps in the work of design and control of a concrete mix in the field are, secure ample information in advance as to the characteristics of the materials with which you have to work, design a mix to meet your requirements with the minimum quantity of cement and the maximum workability, check the materialsfrequently in the field, and make any changes necessary either in the mix or its manipulation to keep the concrete within the limits of your design, make sufficient compressive strength tests to assure yourself that the design is workable and being properly carried out, keep ample records, and above all, develop and follow a consistent technique.

NOTES

Several important mining meetings will be held in the west this autumn, among which are those mentioned below which are of special interest to the mining engineers and operators of the Pacific Northwest.

A joint meeting to be held in Spokane and the Coeur d'Alene district in Idaho, will be participated in as follows:

Northwest Mining Association—Sept-30 will hold its 35th annual convention at Spokane.

American Mining Congress, Western Division—October 1 and 2 in annual meeting at Spokane.

American Institute of Mining and Metallurgical Engineers, Regional meeting, October 3 at Spokane; at Kellogg-Wallace, Idaho, October 4-5.

Full programs will be provided for all these meetings and many technical and scientific papers will be read. In the Coeur d'Alenes the visitors will be shown through the Tainton Zinc Plant and the Bunker Hill Lead Smelter and Refinery the first day, to be followed by a dinner in Wallace, where operating problems of the zinc plant will be discussed. During the second day, mines and other plants will be visited.

Following these meetings the Canadian Institute of Mining and Metallurgy will hold the General Western Meeting at Edmonton, Alberta, where many will go from Spokane and elsewhere to attend, October 9, 10 and 11.

Reduced railway rates will prevail through the identificate certificate plan or otherwise.

These meetings indicate, not only an increasing interest in mining, but also, through the character of the papers, mastery of details of the sciences and arts related to that great basis industry.

Use of the microscope in analyses for a wide range of determinations is becoming a major agency whose field can be extended to advantage.

Members of the Northwest Scientific Association are urged to make early preparation of papers for the next annual meeting which will be held near the end of December. Titles of papers should be submitted to the secretary and the earlier he is advised the better it will serve and guide him in the preparation of a program. It has already been suggested that astronomy and meteorology might be combined to find a place on the program. It has also been noted that the Association is an excellent medium through which to preserve early Northwest history, that as time passes the pioneer class disappears or diminishes and valuable records are thereby lost. Members are invited to suggest subjects of a desirable character in order that some one may be found competent and good enough to supply the data thereon. Other suggestions as to program are invited.

Dr. Richard G. Tyler, recently of the Massachusetts Institute of Technology has accepted the deanship of the College of Engineering at the University of Washington.

At the recent meeting of the Western Farm Economics Association which was held at Corvallis, Oregon, the following were elected; President, Dr. H. D. Scudder, chief of farm management, Oregon State College; Vice-President, Dr. A. F. Vass, university of Wyoming; Secretary Prof. W. P. Thomas, Utah Agricultural College. Next year's meeting will be held in Utah.

A chemical fertilizer plant to cost approximately $8,000,000 is to be constructed at Trail, B. C., by the Consolidated Mining & Smelting Company, whereby a nuisance becomes a blessing through the utilization of waste gases now causing great damage, but which converted into usable products, will increase the yield of food crops.

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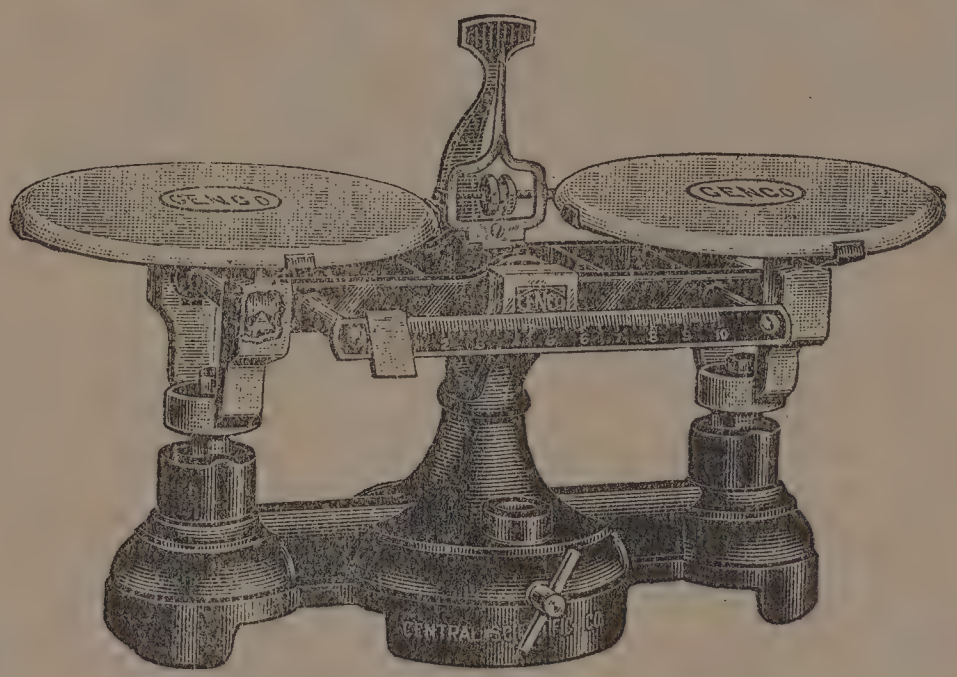

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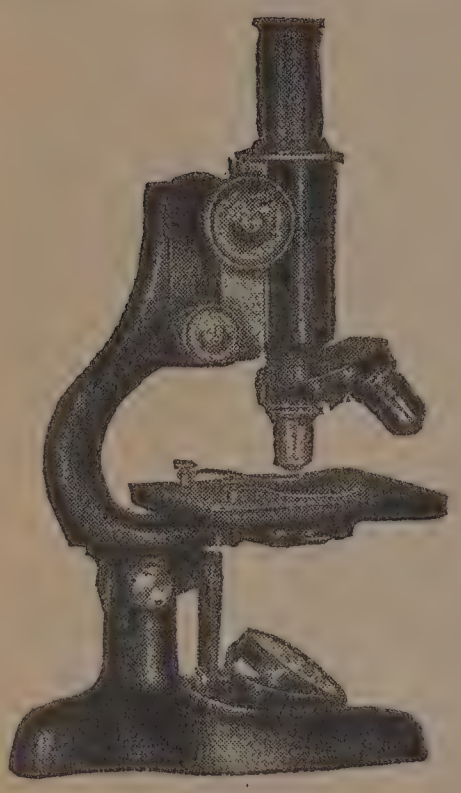

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NORTHWEST SCIENCE

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SOME FUNGI OF NORTHERN IDAHO*

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INTRODUCTION

By way of introduction I might say that the classification of fungi seems at present to be in a rather unstable condition. No two classifications agree in all respects. They not only differ in regard to the order and family names, but in generic and specific names as well. Furthermore, the majority of publications deal with fungi in only a general way or else consider only the forms of a certain locality. As far as I know, very little has been done with the fungi of the Northwest, and we are greatly in need of a work which will include at least all of our common forms. As it is, I find it necessary to use a dozen or more books in order to identify our common fungi. Some forms are found recorded only in works written in some foreign language. This situation renders a handicap to the students since many of them are unable to read foreign languages. Since the fungi of the Northwest are very abundant it will be impossible to consider all of them at this time. I will, therefore, deal with but a few of the groups and hope to be able later to treat the other groups in a somewhat similar manner.

I wish to consider only the more common forms of the Helvellales (Ascomycetes) and the Auriculariales, Tremellales, and Nidulariaceae (Basidiomycetes).

Order HELVELLALES

All of the forms of this order are saprophytic, growing in most cases on the ground, although a few occur on decayed wood. Most of them have rather conspicuous, stalked, fleshy spore fruits. The hymenium usually covers the entire upper surface of the cap. Representatives of two families of this order are found in this locality (Helvellaceae and Geoglossaceae).

*Original contribution.

Family HELVELLACEAE

Among the Ascomycetes this family, commonly known as the Morels, presents the most conspicuous spore fruits. All of the forms have a distinct stem with a cap or head, the surface of which is covered with the hymenium. These fungi are of especial interest because of their edibility, which in the Ascomycetes is practically limited to this family. Although none of the species are regarded as poisonous, there is some doubt as to the desirability of eating some of the forms, especially if eaten in considerable quantities. In this region the Helvellaceae are represented by four genera: *Morchella, Verpa, Helvella, and Gyromitra.*

Genus *Morchella*

In general appearance all of the species of this genus bear considerable resemblances. The cap, which is adnate throughout its length to the stem, is somewhat rounded, oval, cylindrical or conical in shape. It is, as a rule, deeply pitted or ridged, presenting a spongy appearance. The stem is quite brittle and hollow. All of the species are edible and are very easily distinguished from any other fungi. Several species occur in this locality.

Morchella esculenta Pers.—The common Morel.

This is perhaps the most favored of

*Presented at the Meeting of the Northwest Scientific Association, Spokane, Wash., December 27-28. 1929

the Morels, although other species are equally delicious. Undoubtedly some species closely resembling *M. esculenta* are often mistaken for it. This species is recognized chiefly by its rounded or oval, sometimes slightly conical shape, the obtuse edges of the ridges, and the more or less deep pits. The cap is as long as or shorter than the stem. It is yellowish-brown in color.

Morchella deliciosa Fr.—The delicious Morel.

This species is easily mistaken for *M. esculenta,* differing from the latter chiefly in its oblong or cylindrical shape. The cap is usually longer than the stem and two or three times as long as it is broad. Occasionally it is somewhat curved at the top.

Morchella conica Pers.—The conical Morel.

As the name implies, the cap is conical or oblong-conical in shape. The pits in this species are much longer in longitudinal direction than in the species described above. The short transverse ridges which connect the longitudinal ones are so distant that the pits are much longer than broad. When young the plants are of yellowish color but they become considerably darkened with age.

Morchella crassipes Pers.—The Broad-stem Morel.

This species is easily distinguished from other species by the fact that the stem is as broad or nearly as broad as the cap and is often ridged or grooved. The cap somewhat resembles that of *M. esculenta* in regard to the form of its pits, but differs in that the edges of the ridges are more or less acute. The stem is considerably longer than the cap.

Morchella Angusticeps Pk.—The slender capped Morel.

This species very much resembles *M. crassipes,* differing from it mainly in its more or less attenuated and conical cap. The cap, as a rule, is narrower than the stem.

Genus *Verpa*

This genus differs from *Morchella* in that the spore fruits have a smooth or longitudinally ridged cap which is attached to the stem at its apex only. Many authors include the species of this genus under *Morchella.* There is one form *Morchella hybrida* (*M. semilibera D C.*)—which could be classified either as *Morchella* or *Verpa.* It is a form intermediate between the two genera in that only the lower half of the cap is free from the stem.

Verpa bohemica (Kromb.) Schroet—The ribbed Verpa.

This is the *Morchella bispora* Sor. of some authors and is sometimes called the "two-spored Morel", since only two spores are produced in each ascus. It has a rather long stem with a conical, longitudinally ridged cap attached at its apex. This species is edible and quite delicious.

Genus *Helvella*

In this genus the cap is usually attached to the stem at its apex only, as in *Verpa.* It differs from the latter, however, in that the cap is more or less lobed or saddle-shaped instead of conical. Because of this characteristic shape of some of the species, these are sometimes commonly known as the "saddle fungi". The cap may be smooth or more or less wrinkled, folded or convoluted. The stem may be smooth or deeply grooved, fluted or ridged. The plants are quite graceful and attractive. All of them are edible.

Helvella elastica Bull.—The smooth-stem or tough Helvella.

The cap is generally two lobed and saddle-shaped and dark brown in color. It is attached only at the apex of the stem and the lobes are often drooping so that they touch the stem or fold around it. The stem is smooth and more or less tough or elastic, as the name indicates. It is usually cylindrical in shape and varies slightly, if any, in di-

ameter throughout its length. Occasionally, however, the base of the stem is considerably widened and flattened and has short grooves on each side.

Helvella crispa (Scop.) Fr.—The fluted-stem or white Helvella.

This species differs from *H. elastica* in having a deeply ribbed and hollowed stem and a more irregular cap. The stem is usually somewhat flattened and whitish in color. The grooves are distinctly longitudinal. The cap is usually much wrinkled or lobed and of a light brown to white color. It is very fragile and becomes more or less irregularly torn. Sometimes the cap has a deep notch in the center and is very irregular but it is never distinctly convoluted. The variation in the shape of the cap is so great that it is almost impossible to find two specimens that are alike.

Helvella lacunosa Afz—The black capped or dark Helvella.

This species very much resembles *H. crispa,* differing from it chiefly in that the cap is darker and the lower margin of the cap is connected with the stem at points of contact. The cap usually consists of a number of more or less distinct lobes instead of just two as in some species.

Geuns *Gyromitra*

This genus is closely related to *Helvella* and by some authors is included in that genus. It differs from *Helvella* in that it has a more convoluted cap, as the name signifies. Furthermore, the folds become attached to the stem at various points. Although the cap is often very greatly convoluted, it never becomes pitted as in *Morchella.*

Gyromitra esculenta (Pers.) Fr.

This is a common species of *Gyromitra.* The cap is somewhat rounded in general outline but very irregular, forming brain-like convolutions which are attached to the stem at various places. It is usually dark brown or reddish-brown in color. The stem is cylindrical, smooth and hollow and much lighter in color than the cap. Although this fungus is generally regarded as edible, there is considerable danger in eating it, especially if old plants are used or if eaten in large quantities. This is perhaps the only fungus among the Helvellaceae upon which considerable doubt has been cast in regard to its edibility. Many people have eaten it without any ill effects, while on the other hand, authentic cases of sickness and even fatal results have been reported. It is believed that these unpleasant circumstances were due to the use of old or deteriorated specimens. Attempts have been made to determine the nature of the poisonous substance and a number of explanations have been given. It has been found that *choline,* an alkaloid of wide occurrence in both plants and animals, is present in *Gyromitra esculenta.* This alkaloid is not very toxic and if taken in small quantities will cause no ill effects. However, on the decay of the fungus, the choline unites with oxygen and is transformed into *neurin,* an extremely deadly alkaloid closely related to *muscarine.* Helvellic acid, which is also a deadly poison, has been found to be present in old or decaying specimens. This, however, is quite soluble in hot water and if the specimens are boiled, the water thrown away, and then boiled again, the danger of being poisoned from the acid should be eliminated. Altho there seems to be no doubt that young and fresh specimens are free from any poison, we should hesitate to use this fungus for the table.

Family Geoglossaceae

The spore fruits of this family are stalked as in the Helvellacae, but differ chiefly in that the fertile portion is not always distinct from the stalk. Only one genus has been found to occur commonly in this region.

Genus *Spathularia*

This genus is characterized by having spatula-like spore fruits, as the name in-

dicates. The cap usually extends down the stem on two sides.

Spathularia clavata

These plants are very small, varying from about 2 to 4 cm in height. The fact that they usually occur in great numbers, forming densely packed masses, makes them easily recognizable. They are yellowish in color and more or less fleshy. The cap is somewhat flattened, wavy and wrinkled. The spores are very long, narrow and septate and are arranged in a parallel bundle in the ascus. This fungus is edible but is usually not collected for this purpose because of its small size.

Order Auriculariales

The fungi of this order are saprophytic, forming gelatinous spore fruits. These together with the Tremallales are commonly known as the trembling or jelly fungi. The Auriculariales are further distinguished by having transversely septate basidia. In this respect they agree with the rusts and smuts which are parasitic fungi and do not produce any definite spore fruits.

Genus *Hirneola* Fr. (*Auricularia* Bull..)

The Auriculariales are represented in this locality by only one form—*Hirneola auricula-judae* (Linn.) Berk.—the Jew's-ear fungus. The name *Auricularia auricula-judae* (Linn.) Schroet, is used by some authors. This fungus is found on decaying wood, usually in considerable numbers in the more dense regions of the forests. The spore fruit, which is of a tough gelatinous nature, resembles the human ear in its form. It is dark brown or reddish brown in color when fresh. Upon drying it becomes externally dark and hairy. It is an edible fungus.

Order Tremellales

The Tremellales resembles the Auriculariales in having gelatinous spore fruits, but differ from them in that their basidia are obliquely or longitudinally septate. All of them are edible but many are too small to be of any value.

Genus *Tremella*

The spore fruits of this genus are much folded, wrinkled or brain-like. They are usually white, yellow or orange in color. They retain their color when dried.

Tremella mesenterica (Retz.) Fr.—The orange Tremella.

This fungus grows on decaying wood and is quite abundant on old burnt-over stumps. The spore fruits are bright orange or yellow in color. They are much folded or brain-like, gelatinous but firm, and often spread over a considerable portion of the wood.

Genus *Exidia*

The spore fruits are more or less globose or spread out. They are smooth or somewhat wrinkled and the surface is covered with small elevations or papillae.

Exidia glandulosa (Bull.) Fr.—Witch's butter or black jelly.

This species is quite common, especially on dead alder. During damp weather the spore fruits are swelled up into rather large, soft, gelatinous masses. In dry weather they become hard, black incrustations on the branches, but when young and fresh are considerably lighter in color.

Genus *Tremellodon*

The spore fruits of this genus are more or less spathulate or fan-shaped. They may be sessile, dimidiate or attached by a short stalk. The forms of this genus differ from other Tremellales by the hymenium being on short spines or teeth which cover the under side of the spore fruit. This genus is sometimes incorrectly classified with the Hydnaceae. They resemble the latter only in the type of hymenophore, but differ in having a gelatinous spore fruit and septate basidia.

Tremellodon gelatinosum (Scop.) Pers.—Jelly spine.

The spore fruits are more or less white with a slightly bluish tinge. The spines are white, straight and conical, usually only several mm long. This fungus is

rather rare. It grows on decaying wood or on the ground.

Genus *Gyrocephalus*

This genus differs from other Tremellales in having a more erect spore fruit and in having the hymenium confined to a smooth lower surface of the fruiting body.

Gyrocephalus rufus (Jacq.) Bref.

This is the *Guepinia helvelloides* (D C.) Fr. of some authors. The spore fruits are more or less deeply infundibuliform or subspathulate. They grow erect on the ground, usually from buried wood. The base is stout and somewhat cylindrical and the top is expanded or flattened. The plants vary from a reddish yellow to a reddish color. They become very small and hard when dried, but revive when moistened.

Family NIDULARIACEAE

These fungi, commonly known as the bird's nest fungi, are closely related to the puff-balls. The spore fruits, which are very small, often grow in clusters on wood or on the ground. They may be somewhat globose, cup-shaped or funnel-shaped. The wall of the spore fruit (peridium) may be composed of one, two or three layers. The peridium opens at maturity to expose the spore bodies (peridiola), which resemble eggs in a nest. In some genera the peridium opens before maturity but the peridiola remain concealed by a thin membrane known as the epiphragm. The peridiola are more or less flattened or lenticular in shape. They may or may not be attached to the peridium by interwoven threads of hyphae known as the funiculus. The Nidulariaceae are represented here by three common genera: *Nidularia, Crucibulum and Cyathus.*

Genus *Nidularia*

The spore fruits are globose or subglobose. The peridium is composed of one layer and does not have an epiphragm. It opens at maturity by the rupture of its upper portion in a circumscissile manner. The peridiola, which are very numerous, do not have a funiculus but are imbedded in a gelitinous substance. They are brown in color. A common species is *N. pisiformis* (Roth) Tul.

Genus *Crucibulum*

In general appearance the spore fruits of this genus resemble those of *Nidularia.* The peridium is composed of two layers and is closed by an epiphragm which later becomes broken. The peridiola are attached by a funiculus which is enlarged at the point of their connection. The peridiola are somewhat larger and of a paler color than those of *Nidularia. Crucibulum vulgare* Tul. is the common species.

Genus *Cyathus*

The spore fruits are at first more or less cylindrical but finally become broadly campanulate. The peridium consists of three layers and is closed by an epiphragm which becomes torn and disappears as in *Crucibulum.* The peridiola are large and black or gray in color. They are attached by a funiculus without a papilla. *Cyathus vernicosus* (Bull.) DC. (C. olla (Batsch.) Pers.) is quite common in gardens on the ground or on rotten wood.

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PRESENT STATUS OF INTELLIGENCE TESTING*

I. N. MADSEN

State Normal School, Lewiston, Idaho

For the purposes of this paper, I shall define intelligence as being the type of inborn capacity which is measured by such individual tests as the Stanford Revision of the Binet-Simon and by such group tests as the Army Alpha. This type of intelligence has been characterized as the capacity to make adaptions to novel situations, as learning capacity, or as ability to deal with abstractions. It is regarded as being more or less distinct from certain other inborn capacities and traits such as mechanical aptitude, musical talent, traits of character, temperament, emotionality, and the like. It is likely that the direction in which and the force with which intelligence so defines is applied, depends considerably upon such capacities and traits as those listed above. Nevertheless, intelligence is held to be the key without which the doors which lead to leadership or eminence in the multitudinous professions and vocations which characterize modern civilization remain locked.

Intelligence, as defined above, can now be measured with a high degree of validity and reliability. I make this statement in the face of much skepticism among the public in general and the educated layman in particular that such apparently simple devises as modern intelligence tests can measure so important a trait. The evidence in support of the statement just made is considerable. The validity of a test (whether it really measures what it purports to measure) has been the most difficult to determine. In brief, the method has been to apply the tests to unselected groups and then to compare the resultant scores with estimates of each individual's intelligence made by competent observers of the individual's concerned. In other words, if an individual's intelligence functions as the intelligence score predicts it should, we have evidence of the validity of the test. The reliability of a test (self-agreement) has been easier to determine. This is merely a matter of applying the correlation technique which enables us to state mathematically the closeness with which we may expect to get the same results on re-tests. The reliability of the better intelligence tests has been found to be very satisfactory indeed.

Before leaving this general discussion of the nature of intelligence and its measurement, I must mention the very important characteristic of constancy of score, or in terms of the Stanford-Binet, of the I. Q., when measuring an individual's intelligence at varying intervals of time. While perfect constancy has not been established, due either to actual changes in innate intelligence or, what is more likely, to the imperfections still inherent in our measuring instruments, it has been found great enough to warrant the statement that there is no other trait about which we can predict with as much accuracy and certainty as we can about intelligence.

I shall pass now to a consideration of the practical implications and questions which have arisen in connection with the measurement of intelligence and more particularly in connection with the uses suggested of the results. Probably no other issue has caused so much commotion and controversy within educational circles as well as among other groups as the measurement of intelligence and the uses to be made thereof. We all recall the Terman - Bagley - Lippman - Whipple-Rusk controversy of a few years ago which assumed international proportions before it simmered down. The protagonists of the measurement of intelligence and its use in school were as-

*Presented at the Meeting of the Northwest Scientific Association, Spokane, Wash., December 27-28, 1929

sailed by Bagley and his cohorts as "Educational Determinists". It was even implied that the foundations of democracy were endangered. From lay writers with certain political and social leanings came charges of propaganda in favor of perpetuating the present social structure, in favor of the perpetuation of social classes, in favor of certain races or nationalities. As might be expected, this group contributed more heat to the discussion than information.

It was perhaps unavoidable that a subject of so much inherent interest should receive so wide a public discussion before the controversial phases had been subjected to closer study by the leaders in the field. This has been unfortunate in that many of the issues have been left unsettled or beclouded in the mind of the public. According to some: "The idea that intelligence can be measured or that people differ from birth in the amount they possess, has been knocked into a cocked hat". This group puts its faith in the Declaration of Independence although that document does not pretend to treat of indifferences in mental gifts. According to another group: "There orter be a law". Just what the law should be depends upon the particular hobby of its proponent. Some would apply the law to the proper selection of a mate, others to the regulation of immigration, and the like. In spite of such diverse conclusions among the layity, there is a considerable body of principles derived from our present conception of the nature of intelligence and its measurement on which the vast maiority of competent students find themselves in agreement. I shall proceed to state these as concisely as possible without the attempt to give chapter and verse for my authority. For convenience, I shall classify these principles in accordance with whether they bear primarily upon educational policies or upon general social policies.

Among the more important principles pertaining to educational policy, we may list the following:

1. That differences in inborn intelligences are great and important enough so that they should be recognized and unilized by school and society if Democracy in the best sense is to survive.

2. That this does not imply that educational opportunity should be withheld from any element in the population.

3. On the contrary, failure to recognize individual differences in intelligence results in gross injustice and hardship to the pupils. In other words, we must reject the Procrustean idea of attempting to fit all individuals to the same mold. This principle is already accepted in practice where the policy has been adopted to fit the school to the child rather than attempting to fit the child to the school.

4. We must recognize the dignity and worth of all socially useful vocations. Happiness does not demand that all should prepare for a given vocation or group of vocations.

5. There is at present an unfortunate attitude among the public reflected in student bodies which belittles the capacity for scholarship. It is manifested in such expressions as "high-brow" and "book-worm". This attitude cannot but dampen the enthusiasm for scholarship which ought to be engendered especially in this group. It is from this group that we must expect leadership in the various learned groups in science, discovery, and invention. At present, if any injustice is done to any group of students, it is to this group of potential leaders. In the typical city school system, the per capita cost for this group is less than for any other group. What cost in money would be too great if among this group of students, a genius could be trained who would solve for us the treatment and cure of cancer, or one of the many other problems that baffle solution at present?

6. The ideals of Democracy do not require a levelling-up or a levelling-down process; and there is no inconsistency between Democracy and outstanding leadership in a given field. Our schools and colleges apparently have accepted this

principle so far as the development of brawn is concerned. Witness the million dollar stadiums built to exhibit the physical prowess of twice eleven trained athletics. If it is not injurious to Democracy thus to glorify brawn, where is the harm in similarly glorifying and developing brain? The two will sometimes be found to reside in the same individual, public opinion to the contrary not withstanding.

Among the more important principles pertaining to other social considerations than those of education, are the following:

1. Human heredity is subject to the same biological laws as is all life in general. This implies the operation of the law of natural selection and doubtless explains why certain sections of mother earth have bred what appear to be abler mental types than other sections. This principle implies also the possibility of applying purposeful planning in the improvement of the human race as has long been done in the plant and animal kingdoms.

2. An enlightened policy of eugenics can be formulated and effected by society. The difficulties to be overcome are great but not insurmountable. We can probably all agree that it is in line with humanitarian principles as well as with public policy that mental defectives of idiot, imbecile, and moron grade should not reproduce. Nevertheless false sentimentality and doctrinaire individuals and groups make it very difficult to make a start. Thus up to 1928, there had been in the United States less than 9000 eugenic sterilization of which nearly 6,000 were in the one state of California. Up to this time only 21 states had eugenic laws of any kind. It is interestin to note that in one of these states, Virginia, such a law which was passed was carried to the United States Supreme Court and was sustained by that body. In one recent year, California spent more than $3,500,000.00 to support its six insane asylums and the Sonoma State Home for the feeble-minded. This does not include an equally large sum for prissons and reform schools. In spite of these large sums they are but a drop in the bucket in comparison to what they would be if all the individuals meriting it were housed in such institutions. According to Terman's figures, there are from one to three percent of feeble-minded individuals in a typical community. Thus if we grant California a population of three million people, there would be between thirty and ninety thousand feeble-minded. The majority of these are at large and are breeding prolifically of their own type. With the blessings, if so they be, of birth-control appropriated and practised by the more intelligent, it would not be difficult for a statistician with a gloomy bent of mind to predict the down-fall of Rome. Incidentally, I recommend to anyone interested in history to reread the stories of the rise and fall of numerous civilizations and nations in the light of biological changes which have taken place in the racial stock on which the civilization or nation was founded.

It is clear that if anything eugenically is to be accomplished, we must do much more than to follow our present haphazard methods. If our energetic and enthusiastic birth-controllers could do something to transfer the incidence of its operation to the other end of the scale, they would be doing a truly humanitarian service by decreasing the amount of human misery always found so abundantly among the mentally deficient. They would at the same time be accelerating human progress by increasing the mental health and vigor of the race.

3. It was inevitable that racial and national comparisons should be made and that this should cause much bitter discussion. After all has been said and the evidence sifted, we are left with such facts as the following: (1) The range of intelligence in each race or nationality is great. (2) according to the best and

most unbiased evidence there are significant differences in the average intelligence of certain races. (3) These differences are somewhat obscured by overlapping caused by individual differences within each race. (4) All races and nationalities have within themselves the germs of greatness. (5) Through misfortune or otherwise they have not equally developed or husbanded these potentialities. (6) For purposes of determining a sane immigration policy, the intelligence of the individuals and groups admitted is of great importance. (7) Other traits, however, may be of equal importance. We have already recognized this in the practical exclusion of an intelligent people such as the Japanese. In this case the mere differences in race is sufficient to invite grave social disturbances if large numbers were admitted. If it is desirable to develop homogeneity in language, customs, national culture, religion, etc., such matters should also be taken into consideration in addition to the biological factors listed above. While these factors are not of so permanent a nature as the biological factors, they are nevertheless of sufficient persistence to introduce considerable discord and it may even tend to increase in intensity rather than to diminish.

DEFINITIONS IN CHEMISTRY AND MATHEMATHICS*

By Thomas M. Dahm

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As scientists, we seek, first of all to see things clearly. As teachers, we try from our first contact with our students to develop in them habits of careful analysis and of clear statement. We have, however, some blind spots. I suppose we are comparable in one way or another to the ancient alchemists, our predecessors, who sought faithfully and long for that magic substance, the universal solvent, until some bright young man (with a mind not yet molded to the pattern of his time) naively inquired as to the nature of the container in which we proposed to keep this universal solvent.

In our attempts to convey new ideas to our students we make use of definitions. A definition is expected to convey to the student in brief form as much information as possible on the nature of the quantity defined. Above all, a definition should not obscure the nature of the quantity defined or mislead the student. Knowing the immaturity of many of our students and their limited experience in the evaluation of language (their general lack of ability to really read) we have sought to simplify our definitions and to restrict their content. We have carried this effort so far that some of our definitions when literally interpreted are contrary to fact. How can we induce our students to draw a sharp distinction between the natures of the quantities pressure and force if we ourselves have declared their essential identity by telling our students that *pressure is the force that acts on unit area?* Or if we retain an ancient formula that defines the coefficient of friction as the ratio of the *force* of friction to the normal *pressure?* From the standpoint of dimensional reasoning, we have concealed the fact that the value of a pressure is obtained by dividing the force that acts on an area by that area. Why is it not much better to take that fact as the definition of pressure?

To be sufficiently educated to begin the study of Physics, our students should certainly have learned the full significance of the ratio of two quantities. Before entering high school they have learned to add 3 to 5 and get 8, to add 3 cows to 5 cows and get 8 cows, not to add 3 horses to 5 cows unless they wish

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to get 8 mamalian quadrupeds to multiply a herd of 8 cows by 2 to get 16 cows, and to divide a herd of 15 cows into 3 parts of 5 cows each. They have also learned, I think, to divide 15 cows by 3 cows for the purpose of discovering that the result is the abstract number 5, although they would prefer to say that one herd is 5 times as large as the other. However, they respond with gales of laughter to the idea of dividing 16 cows by 3 horses. Furthermore 16 square cows is entirely meaningless to them, even though 16 square feet is accepted as a quantity having a real meaning. Yet, in Physics, we expect them to have no difficulty with the idea of dividing 30 feet by 5 seconds to get that new and strange thing, a speed of 6 feet per second. We do not assist them in their groping efforts to acquire understanding of this new type of relationship when we dodge the issue by defining velocity as the distance travelled in unit time rather than as the quotient of the distance traversed and the time required to traverse it. We then go on to befuddle them completely by defining acceleration as the change in velocity that occurs in unit time. Is it any wonder that our students resent our insistence that they "write down the units" when working problems? They have not been taught to feel that the result of dividing 30 feet by 5 seconds is only completely expressed by the whole statement "6 feet per second". When we make them write down the acceleration of gravity as 32 ft./sec. 2 they are perfectly sure that we have put on them the duty of remembering some perfectly senseless jargon,—as is indeed the case if we do nothing to broaden their number concept.

While I have not in my own teaching gone so far, I wonder if we would not give a clearer idea of the relationship between the quantities force, mass, and acceleration if we defined the dyne as the force that must act on any given mass when this force gives such an acceleration to the mass that the product of mass and acceleration, each expressed in C. G. S. units, has the numerical value unity. Instead, we say that the dyne is the force that will give a mass of one gram an acceleration of one centimeter per second per second, effectually concealing the fact that mass and acceleration are to be multiplied together rather than, say, divided. I have here chosen a case in which the unavoidable clumsiness of the definition may overbalance its other merits.

In my experience as a student and teacher I can remember nothing so difficult to understand or to explain to another as the concepts of electric or magnetic field strength and potential difference. Does not the root of the difficulty lie in the fact that we continually speak of field strength as a force and potential difference as an amount of work, in complete contradiction to what we know about the dimensions of these quantities?

It will be noted that the type of definition that I think useful frequently involves a simple algebraic equation the translation of which from algebraic shorthand into plain English constitutes the definition. Is it improper for the teacher of Physics to seek to cure the ague that prickles the spines of many of our students when one is inconsiderate enough to mention that dreadful branch of mathematics known as algebra? Furthermore, some of the laborious proving of formulae is thus eliminated. For example, if one defines Young's Modulus as the ratio of stress to strain and then properly defines these two quantities, the formula is already derived. Contrast this method with the statement that Young's Modulus is the force that would stretch a wire of unit cross-section to twice its original length,—a perfect example of concealment of content, the sole merit of which is that it is very easy to remember.

In the field of Mathematics, my introduction to trigonometry was far in the

past before I realized that the sine of an angle is the same kind of quantity as angle itself and that these quantities are non-dimensional. I lay this failure to grasp signifinance to the fact that the author of my text book introduced me to certain individual lines associated with a circle of unit radius as truly equivalent to the various trigonometric functions.

To one even slightly informed as to the importance of complex quantity, not only in pure mathematics, but also in the difficult problems of electrical engineering, the name "imaginary" for the square root of a negative quantity is almost tragic. While we cannot discard our inherited terminology, we can lead the student to broaden his concept of number by suggesting to him that his difficulty with "i" is of the same nature as the difficulty a simple savage would have in attaining mastery of the idea of negative number when his experience has taught him that one cannot possibly remove seven fish from a strand of vegetable fiber if there are but five on it. Under the economic system of barter he has never been in debt, and he has never seen a thermometer.

One must, I think, allow in the introduction to a new topic some simplified definitions, but if the word "numerically" is emphasized in, for example, the statement that velocity is numerically equal to the distance traversed in unit time some chance of attaining a true concept is still left to the student. But before consideration of the topic is finished such definitions should be superseded by better ones.

The emphasis on relationship that results from continually combining an algebraic statement with the equivalent English statement leads the student naturally and easily to the important concept of dimensions, a concept that is now too often beyond his comprehension.

THE LIFE AND WORK OF DR. J. E. KIRKWOOD*

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The development of those characters which made Dr. Kirkwood a success can undoubtedly be traced to his early boyhood days, and to the type of schooling that he received. Dr. Kirkwood's confidential moods were not many, but I well remember some of the things he told me about his early life and education. His earliest boyhood was spent in Iowa, but in 1884, when Joseph Edward was a boy of 12 years, the family moved into the upper Williamette Valley in Western Oregon. This region was then practically a wilderness. The family found that the struggle for existence was not easy. Dr. Kirkwood spoke several times, of how hard he had worked to do his share in the support of the family. doing a man's work beside his father. I remember of his telling of taking one end of the cross-cut saw and working right with his father thruout the day, soon after the family arrived in Oregon. Life was not an easy matter, and there was little if any time for play. It was a question of survival, and survival meant the procuring of the common necessities of life; shelter, clothing, fuel, and last, but not least, food. Furthermore the family was intensively religious, and among other things, one responsible to his God finds time too precious to be squandered in foolishness. Then, too, in those days the pioneers and their children did not have the distracting diversions of the present. Life was a serious matter, indeed. The wilderness did not provide much in the way of schooling. I take it that what education he received in Oregon, before he went to the Academy was received largely in the

*Presented at the Meeting of the Northwest Scientific Association, Spokane, Wash., December 27-28, 1929

home, during the winter months, when there was not so much to be done outside. He finally went to Tualatin Academy, located at Pacific Grove, and finished his preparatory work, and then registered in Pacific University, located in the same town. I take it from what he said, that here too, he was largely on his own. I remember of his telling that he used to saw wood for the president, among other things that he did. Just what influenced him to major in Botany, I never heard him say. But I do remember his telling of the severity of his early botanical training. The Professor under whom he took his work was more of a Naturalist than a trained botanist, and knew comparatively little of what was then modern botany. In the smaller institutions of that time, few were interested in botany, and of those who were interested, most knew only descriptive botany. Dr. Kirkwood was provided with a cheap microscope, and sectioning razor, a text or two, and all of the plant material that was available in the environment of the school. It was the old Agassiz method with a vengeance: he had the laboratory and the tools; it was up to him to learn the plant. But it tended to make his training in Botany very narrow, and he told me that the early days as a post-graduate student were painful, when he began to realize how little he really knew, At the same time, the capacity for individual and independent work which he developed there at Oregon, together with a natural love for the outdoors and its dominating vegetation, was what made him the great pioneer botanist that he was. He received his B. A. in 1898. His work at Pacific University must have been of a high order, for we find him going to Princeton University the following year on a private fellowship. The following year, he was at Columbia with a graduate assistantship. In 1901, he was married, and accepted an instructorship at Syracuse University. At this institution he not only taught, but continued his graduate work as well, for he received his A. M. from Princeton in 1902, and his Ph. D. from Columbia in 1903. These facts are told in order that some conception of the young man's great capacity for work may be appreciated. He completed the work for two degrees in four years time, teaching and having the responsibilities of a home as well during the last two years. He ranked as associate Professor of Botany at Syracuse from 1904 to 1907, and in 1907 was made full Professor, and Chairman of his Department. One other thing that contributed to his success was the fact that he was gifted artistically. It seems to run in the family, for his sister is an artist, and some of her paintings of flowers are as good as anything that I have seen, as well, his daughter Mary shows promise in art; at the present time she is teaching and taking post-graduate work in the Art School at the University of Oregon. All of Dr. Kirkwood's drawings are unusual, for they combine accuracy and artistry.

The first research of which I have found record was done in collaboration with Dr. William Gies. The paper was entitled "Chemical Studies of the Cocoanut with some notes on the changes During Germination." I speak of this not only because it was his first paper, but also because the drawings are his, and show that characteristic of scientific accuracy, combined with his artistic ability. This paper also indicates sound training in both plant physiology and plant morphology.

His next paper was on "The vegetation of northwestern Oregon." This showed an early interest not only in Systematic Botany, but also in some of the problems which are encountered when it comes to an understanding of all that lies behind the distribution of plants. After this, in School Science for 1903, he published another paper on the cocoanut.

His next paper was submitted to the faculty of Columbia University in 1903 in partial fulfillment of the degree of Dr. of Philosophy. His thesis was entitled

"The comparative embryology of the Cucurbitaceae", and shows all of the characteristics of sound scholarship and detailed and painstaking study, which characterized his work all thru life. The drawings are all made from material killed, embedded and stained by himself. Most of the slides are still on file in the Department, and I remember he told me with considerable pride, that Dr. Edmund B. Wilson, our great American Cytologist, had warmly complimented him upon his technique in killing and staining. His drawings are all made to scale, and show that attention to detail, and the fine artistry which is apt to characterize the work of the European authors, but which is so apt to be lacking in the work of many Americans. His historical treatment and bibliography shows that he had been well trained in the fact that any real piece of scientific work necessitated going back into the earliest published records, and not just a scanning of the more recent work. This is a criticism that is made of much American work at the present time. He was granted a research fellowship at N. Y. Botanical Garden during the summer of 1904, and published the results of this work while at Syracuse University, in 1906. This paper was entitled "The Pollen-tube in some of the Cucurbitaceae"

In 1907 he published still another paper entitled, "Some Features of Pollen Formation in the Cucurbitaceae." This year might be considered as ending his formal supervised training. From now on, he was largely on his own.

The next few years were apparently too full to permit much chance for independent investigation. The year of 1907-8 he spent as assistant Botanist with the Continental Mexican Rubber Co., at Torreon, Mexico. A research staff employed by this company was investigating native American plants which might be used as a source of rubber, centering their attack on the Guayule. Apparently this year left a bad taste in his mouth, for he never did have much to say concerning it. He told me once that he thought a man was foolish to think of going into commercial enterprises, for quick results were desired, and if they were not forthcoming, the problem was usually closed. The next year he spent as an investigator at the Carnegie Desert Laboratory at Tucson, Arizona. I imagine, though I cannot recall his saying that he continued here some detailed investigations as to rubber producing plants. At any rate, there followed in close sucession the following papers based largely, I believe on his work in Mexico and Arizona: "The Life History of Parthenium", "Some Mexican Fiber Plants", "The growing of Guayule in Relation to Soil", "Desert Scenes in Zacatecas" and a popular article of merit entitled; "A Mexican Hacienda" in the National Geographic Magazine in 1914.

He came to the State University of Montana as Assistant Professor of Botany and Forestry in 1909, under Dr. Elrod, in the Department of Biology. The next year, the Department of Botany was established as separate from the Department of Biology, and Dr. Kirkwood was made Chairman of the new Department, and Professor of Botany and Forestry. He was at least in part responsible for the giving or instrumental work in Forestry subjects until 1914, when the Forestry School was organized, and his title was changed to Professor of Botany, instead of Professor of Botany and Forestry.

During these early years at the University he was apparently so busy with the task of building a new department-carrying the whole teaching load himself, that for a time there was no chance for organized research. In 1916 he published a short note on the "Bisporangiate Cones of Larix." But, though busy during this interval, he found time for field notes and observations, for in 1918, the Bureau of Education published his "The Conifers of the Northern Rockies." In 1918, also, he published a short article in "School

Science and Mathematics," "On the Oportunity and Obligation in Botanical Teaching."

In 1922 came a work of major importance, his "Forest Distribution in the Northern Rockies", a very able treatment on the ecology of the trees in particular, but also including much in reference to shrubs. This work was based largely on his experiences in the field, and we might suppose that he began to lay the groundwork for it from the time when he first came to Montana. It reveals his capacity for keen analysis, and his painstaking attention to the smallest of details. These qualities, together with his natural love for the outdoors, and his great capacity for sustained hard work, were what made him the remarkable field man that he really was. In 1922 there also appeared a short article in the Journal of Home Economics, entitled "Botanical Instruction for Students of Home Economics". Then follow in 1926, 1927, and 1928, four semi-popular papers on his botanical explorations in the Rockies. These papers were a real attempt to do something which he had not as yet done, to popularize his field. He told me that this type of writing was one of the hard est things he had ever tried, but these papers are real contributions, for they are written in very good style, and add to our knowledge of the local flora and its distribution.

During 1925-26 he served on the "Committee on Science Courses" for the Inland Empire Educational Association, of which committee Dr. Elrod was chairman. Both he and Dr. Elrod spent a lot of time collecting data, and in 1927, Dr. Kirkwood read a paper on "Botany in High School and College", in part based on work of this committee, before the science section of the I. E. E. A. This paper was published later in "School Science and Mathematics." In 1928, he published in NORTHWEST SCIENCE, a paper entitled "Notes on Some Forest Seeding Experiments in the Rock Mountains."

Certain it is that his most important publication will be his book on "Trees and Schrubs of the Northern Rockies". At the time of his death, this was still in manuscript form; it had been for quite some time , but had not been published because its illustrations made the cost of publication greater than probable income from the sale of the book. However, a contract has been signed between the State University of Montana and the Stanford Press which will bring about the publication of this Manuscript, probably in the early autumn of the current year. Its publication is in part financed by the University and it will be in the form of a Memorial to Dr. Kirkwood. This is easily the culmination of his life work. The drawings are especially noteworthy, for they show the same capacity for artistry indicated in his early works, and reveal an ability for that attention to small details which was so characteristic of Dr. Kirkwood. This manuscript will make a book of some 500 pages and since Dr. Kirkwood had seen practically every species treated in the book, in the field, it will add much to our literature on the trees and shrubs of the Northern Rockies.

During the later years of his tenure, Dr. Kirkwood's main interest was along ecological and systematic lines. He spent much of his time in the field where he proved himself to be an untiring worker. He explored many regions in Western Montana, and adjacent territories, which had not hitherto been systematically covered by systematic botanists, and added many thousands of plants to the the University herbarium. Aside from the collection of these plants, he took very full field notes.

At the University we have some 1500 different lots of plants, and each lot has from 10-12 duplicates, unless the plant was not found in abundance. One specimen of each number will be placed in our

own herbarium. The remaining of each number will be exchanged for collections from other regions, so that I estimate we will receive at least 10,000 accessions to our herbarium thru Dr. Kirkwood's own labors, besides the ones added thru his own efforts. While others have made collections of Montana's plants at one time or another to my knowledge, none of them have been in any great number. I believe that Dr. Kirkwood should be remembered as Montana's pioneer field botanist and as one of the pioneeer field botanists of the Northwest.

It is unfortunate for us that he died when he did. The earlier years of his life were devoted to teaching; and the building-up of the Department and the gaining of experience in the field. He was just at the stage where his experience in the field, combined with a lightened teaching load, would have made the last ten or fifteen years of his life extremely productive. He had a capacity for sustained endeavor such as is possessed by few, even in the scientific field. He was always enthusiastic in his research work, carrying it forward with the zeal of a much younger man, and he was one of the strongest supporters of research organizations on the campus at Montana.

It would be amiss not to say something about his ability as a teacher. Self discipline from his earliest boyhood days made him very impatient of the student who didn't try. His subject was presented in a clear, lucid fashion, and he expected his students to master what he gave them. His teaching was always sound and he kept careful watch of the individual student. I believe that his favorite words were "precision" and "accuracy." While Dr. Kirkwood did not have the warm personality which some teachers have, yet the well motivated students all respected and revered him for his sound scholarship and his moral integrity. This was especially true of the students in the School of Forestry, with whom he had intimate contact, since much of their basis work is given by the Botany Department. In honor of Dr. Kirkwood and his work, the Forestry Club at the University is establishing a grove of the native trees and shrubs on the campus which is to be known as the "Kirkwood Memorial Grove." That his teaching was successful is substantiated by the fact that a good share of the men whom he helped to train have been strong in their professional work. From his own department he sent a surprisingly large number of students into post-graduate work, and so far as I know all have been a credit to his teaching and to the institution.

His interest was not confined to the University alone. He felt that the workers in science in the northwest were so isolated that they could gain little inspiration, and little help from the National organizations, who almost invariably hold their meetings east of the Mississippi. He had as much or more to do with the formation of the Northwest Scientific Association than any other man. He was its Chancellor in 1925, and served as councillor from then until the time he died. That he had vision is evidenced by his dream of a museum and library combined with a research institute to be located logically, he thought, at Spokane, which would be the center of scientific thought and work in the northwest. He also hoped that the Northwest Scientific Association would be able to find financial aid for the publication of all the worthwhile work which was being done in the northwest. I know that during the last two years he spent a very appreciable amount of his time in aiding in the formulation of tentative plans for the organization of the proposed science center. He also felt that some of the objection to science courses evinced by university students was due to the fact that science courses were not properly taught in our secondary schools. I think that this feeling lay behind his affiliation with the Inland Empire Teacher's Association.

Dr. Kirkwood was too big a man not to have had considerable influence in the development of the University. A man of high ideals and strong opinions, he was fearless in fighting for what he thought was right. He was not always diplomatic, and occasionally made personal enemies, and yet all respected him, for no one could ever doubt his sincerity. He served on many committees which have had to do with the shaping of scholarships standards, university policy, etc., and anyone who knew Dr. Kirkwood well, can easily see the unmistakable signs of his influence upon many things connected with the University. In his death, the University not only lost a strong teacher, but an able and fearless councillor.

A man with Dr. Kirkwood's strong opinions could not help but take a part in community affairs. At one time he played so conspicious a part in the campaign to eliminate the "red-light" district, that his position at the University was jeopardized. During the year just previous to his death he had also acted as chairman of the county committee for the re-enactment of the state legislation which would place responsibility for the enforcement of the Volstead Act upon the shoulders of the state officers as well as in the hands of the federal agents. His conscience did not permit him to fail to do his part in anything which he thought to be for the best interests of the University or the community.

Dr. Kirkwood was a Fellow of the A. A. A. S. and a member of the Botany Society of America, of the Ecological Society of America, American Association of University Professors, Torrey Botanical Club, Northwest Scientific Association, Inland Empire Teachers Association, of Sigma Xi, and Phi Sigma.

In attempting to compile a list of Dr. Kirkwood's publications, I have located 21 titles, besides the 500 page book which is in press.

I was associated with Dr. Kirkwood during seven years. Two men seldom work together so long without some disagreements, and we had ours. But in all that time, I never knew Dr. Kirkwood to say or do anything which was the least underhanded. As head of his department he was somewhat more autocratic than most, but he sincerely believed that it was the proper thing. I always admired his sound scholarship and keen mind, his capacity for attention to the minutest of details. Above all, I admired him for his uncompromising attitude in fighting for what he thought to be right. With his death, I feel that I lost a kindly advisor, and a sincere friend. I think that all who knew him, or of him must feel his loss, too; for no man who has accomplished what Dr. Kirkwood did can pass to the beyond without leaving his "footprints on the sands of time."

Demand for Topographic Maps

The increasing demand for topographic maps has caused President Hoover to urge a more liberal policy on the part of the Federal government to the end that the entire United States may be mapped in a period of 18 rather than 80 years which the rate of mapping heretofore employed would require. In that connection many of the States have been engaged in cooperation with the Federal government on a 50-50 basis as to field work cost while other States, having no such arrangement, are having to wait on the pleasure, convenience or opportunity of the cooperating government agency to their disadvantage. Of all the Pacific Coast States, Washington is the single example of misfortune, having no funds for such work. Montana, Idaho, Oregon and California each have an annual program of cooperation with the result that they are rapidly acquiring information as to the fundamentals of State resources.

GEOLOGICAL INVESTIGATIONS IN THE INLAND EMPIRE IN 1929*

THOMAS LARGE

Lewis & Clark High School, Spokane

Five institutions and several independent investigators have carried on work in the field in the season now coming to a close. The University of Chicago geological party of six under leadership of Dr. J Harlen Bretz was in the field for the eighth season in connection with the "scablands" investigations. A party from the Virginia Polytechnic Institute under the leadership of Prof. J. R. Holden toured the region by motor cars. Prof. Edwin T. Hodge of the University of Oregon continued his investigations of fossils in the John Day River country. Dr. W. C. Alden represented the United States Geological Survey, Section of glacial investigations. The Washington Division of Geology, Department of Conservation and Development and Washington State College Department of Geology have been active on both the east and west sides of the Cascades. The Idaho Bureau of Mines and Geology and the University of Idaho Department of Geology were in the field for that state. Information was not secured from Montana. An unconfirmed rumor states that Dr. W. M. Davis of Harvard University was in the region for a brief visit. His remarkably keen analysis of some physiographic features here made on another brief visit some year ago will be remembered. D. J. J. O'Neill of McGill University, Montreal, Canada, and Dr. Augustus Locke of San Francisco, investigated mining properties in the Metaline district.

A STUDENT RECONNAISSANCE

While the expedition of the Virginia institution is understood to have been strictly an undergraduate educational venture, it is deserving of notice. First, frequently from such exploring expeditions come important investigative projects. Dr. Bretz' first trip with a party into this section was headed for "live glaciers" in the Cascade range. The interest which was found in our unique scablands prevented the party from reaching the glaciers and has resulted in seven annual returns to this field and more discussion and more pages of geological literature, perhaps, than any recent geological topic. Secondly, this Virginia expedition was both unique and daring in that it was co-educational. Many is the coed who has been envious of the opportunities in the geological field open to her brothers but denied to her. A few are permitted in nearby fields but an expedition of twenty or thirty college students equally divided as to sexes that makes a continental tour by motor cars is an innovation. In pregasoline days Dr. Jordan conducted a coeducational "hiking" party from Indiana University to the Wataugua River country of Tennessee. Earlier, Agassiz' famous school on the Island of Pekinese admitted a few young women, and, that able scientist and educator solved the problem for two young men from schools where the culture was not equal to the strain of coeducational endeavor, by landing them on the nearby mainland. In this instance the situation has been frankly met. The wife of the professor chaperoned the young ladies. Night stops were made in tourist camps. And, as reported by young men of another party who had made inquiries, everybody was apparently happy unless it were one or two who were not paired for field work quite to their satisfaction. Of importance to all of us in this region was an occurrence in a town of Montana where some members of the Virginia party met with an accident by collision with a car driven by a local citizen. Two of the

*Read before the Spokane Science Teachers Club.

tourists were severely injured and, as account reached the writer, the local man was entirely to blame. When brought to trial the case, was on some pretext, continued until autumn, a time when it was obviously impossible for the complainants to appear. While this report of the case may not fully express the truth it calls attention to the matter in which there is a danger to which the public should be fully alive. We are inviting tourists in the northwest and are profiting by their visits. Even if selfishness is our highest motive our courts should at least give the visitors an even break in the administration of justice.

MIOCENE FOSSILS OF THE COLUMBIA

No direct report was obtained from Professor Hodge who at this moment is in East Africa, but accounts in the scientific press state that his investigations in the famous fossil beds of eastern Oregon revealed new horizons and many new vertebrate fossils. Such new discoveries may well invite scientists whose atention for a time has been focused in China, but are now interrupted by the government objection to further digging for their dragons, to fruitful fields in a similar line in this intermountain country. The Columbia basalt undoubtedly obliterated many traces, but climatic changes induced by the Cascadian uplift, perhaps in places brought about conditions of readjustment favorable to fossilization of animals of the time as well as of plants such as are so abundantly preserved in the immediate vicinity of Spokane. Elephants, camels, and the giant sloth there undoubtedly were. Others of smaller size must have occupied the area.

This should induce intelligent amateurs and non-experts to collect, preserve and carefully record locality, of any find that suggests the need of investigation by competent paleontologists and may lead to discoveries of new species and of new localities of fossilization. It is a common thing for one to hear of the find of some strange bone which has lain around as a "curio" until either lost or significant data forgotten. We who are not expert in these lines can render no greater service to science than to carefully record data concerning finds of this nature and seek to preserve them in our local museum. A fine example of service of this kind is that of Miss Doris Burchett, a high school student living at Mica, Washington, who on finding fossil leaves in material being taken from a well and used for making a road, made a large collection. These reached the local museum and thereby came to the attention of the late Dr. F. H. Knowlton. This collection marked the highest limit at which the Latah formation has been found, contained fossil leaves which furnished type materials for description of a considerable number of new species of plants, and, in addition, was found to contain a vast number of new diatoms. As teachers we can serve well by spreading knowledge of such possibilities of service. Of great importance is the need of precise information as to locality. There is a difference of opinion in the matter of the museum where specimens should be held, but to me it seems that undoubtedly the proper place for preservation of such materials is our local museum. It is far better to let the experts visit the locality in which finds are made than for the specimens to be lost by shipment to overworked or indifferent specialists at a distance. The only animal fossil which the writer ever found in Latah Formation was given to a representative of the U. S. G. S. and has never been heard of since. In the matter of duplicates it is different but those who urge the sending of all good materials of this character for permanent preservation in distant museums are not working in the best interest of science. It will be remembered that the work of Thomas Condon, the pioneer geologist of Oregon suffered much from careless correspondents.

THE WASHINGTON GEOLOGICAL SURVEY

Dr. H.E. Culver and his staff of the Washington Geological Survey are to be congratulated on their work and discoveries in Stevens County. They promise solution of some of the puzzles of that county in which a number of able geologists have worked. These puzzles are of two kinds: The precise period of deposition of the much metamorphosed sedimentary rocks and the surprising interruptions which occur in promising ore bodies. The following is quoted from his response to my inquiry:

"The investigations whice have been carried on in the last three years have revealed quite a number of unexpected and interesting features, but, as you know a very small portion of our investigations have been carried on in the Inland Empire region." "The fossils to which you refer were found in the Chewelah area in a series of rock formation where only the merest traces of organic matter had been previously reported. During the first season, three years ago, two new fossil localities were discovered, and during the following season at least three new horizons, more or less fossiliferous, were found. The material includes remains of trilobites, brachiopods, pelecypods, and of course less important forms such as crinoids. So far these forms have not been referred to any authority for identification, but with the advent of Dr. Branson, who now has charge of the paleontological work of this department we expect to have the identification made and to know the precise stratigraphical position of the strata from which they were recovered." "Another interesting development which has resulted from Dr. Jones' work in the Stevens County area is the recognition of some of the larger structural features. Perhaps the outstanding fact was of a major overthrust fault which dominates the structures for a short distance to the west of Chewelah. This structure was one which was unrecorded either on the maps or the report of the area and its importance in further stratigraphic work and structural studies can scarcely be overemphasized".

GEOLOGY IN IDAHO

D. A.W. Fahrenwald, Dean of the School of Mines and Director of the Idaho Bureau of Mines and Geoolgy, writes concerning wrk now in progress in Idaho: "The following is submitted"

Dr. F. B. Laney

1. A report on the geology and ore deposits of the Seven Devils region is to be completed in the present college year.

2. An examination of some gold placers along the Secesh River near Burgdorf, Idaho, was conducted the latter part of August of 1929, and laboratory studies are in progress.

3. The water conditions at and near Cascade, Idaho was also made the subject of study in the early part of September of the present year.

Mr. Alfred L. Anderson

1. A report on the geology and the ore deposits of the Lava Creek district, Idaho was written after field work done in 1928 and published as Pamphlet 32 of the Idaho Bureau of Mines and Geology, August, 1929.

2. A paper, Cretaceous and Tertiary Planation in North Idaho, was written during the present year and is listed to appear in an early number of the Journal of Geology.

3. The manuscript on the Geology and Ore Deposits of the Clark Fork district, Idaho, was revised during the present year and is soon to be published as Bulletin 12 of the Idaho Bureau of Mines and Geology.

4. Field work was done in the Clearwater Mountains and laboratory studies are in progress on a report to be issued as the Mineral Resources of the Region about Orofino, Idaho.

5. Laboratory studies are in progress on a paper that is to be offered for pub-

lication in a geologic journal on the origin of the Kamiah asbestos deposits.

6. Manuscript is being written on a problem dealing with certain facies of the mineralization of north Idaho.

7. Several other problems are being carefully studied and will be written for publication in the near future.

Mr. Thomas H. Hite

1. Work partially on a study of the stratigraphy of the state of Idaho.

2. Studies on natural hot water conditions near Boise, Idaho.

3. Field work during the summer of 1929 in the Bayhorse Quadrangle near Challis ,Idaho, in cooperation with the U. S. Geological Survey, Geological mapping of 300 square miles.

4. A study of the origin of the clay deposits of the Latah County, Idaho.

THE "SCABLANDS" —CHICAGO RESTS ITS CASE

Before his departure from the field in August, Dr. Bretz stated that he would not return to this section nevt summer. This statement of course does not commit him positively. He is at liberty to change his mind. In the eight seasons since he discovered the problem of the "scablands" he has built up what to your speaker seems a "water tight" hypothesis to account for this unique phenomenon. If the "Spokane flood" hypothesis does not satisfy all requirements its opponents will have to produce field evidence instead of theoretical objections which have hitherto been raised to refute the evidence of literally hundreds of localities where the energetic doctor has found by minute inspecition positive evidence with practically no negative evidence.

Accompanying the leader in the field this summer were his son, Rudolph, Professor Sam Mayfield of Berea College, Mr. Chang, a brilliant young Chinaman, and Messrs. Imbt and Schluesselman, University of Chicago students. In two motor cars the party covered about three thousand miles in the Inland Empire, within a periphery touching Flathead Lake and Missoula, Montana, White Bird and Coeur d' Alene, Idaho, and Wallula, Yakima, Wenatchee and Okanogan in Washington. In response to the request for a statement of what was accomplished, Dr. Bretz has sent five single spaced typewritten pages which may be read by those interested, but which if offered for publication would be taking unfair advantage of generosity, as this material should first appear in print over his signature. Parts of the letter may be here outlined indicating the extent and character of fieldwork done. In Montana detailed examination was made of the evidences of the Pleistocene "Lake Missoula" of Pardee together with critical examinations of morainic materials of ice lobes invading this territory. This included the ice barrier in Clark Fork valley discussed by Davis and by Anderson together with other lobes reaching the northern border of this lake. Instead of carwindow observation of some interesting structures previously described, Bretz and his party climbed the valley walls and examined some of these appearances with some interesting results. That an outlet of Lake Missoula must have existed to the south of Lake Pend Oreille as supposed Davis was disproved by examination of the crest and for the possibility of channels westward on the mountain flank between Pend Oreille and Coeur d' Alene. Water depths and silts received attention. In the immediate vicinity of Spokane, the moraine in the Twin and Spirit Lakes, Lone Mountain and Rathdrum locality was extended further southward. A fine little relict of a moraine was found on the north shore of Lake Coeur d'Alene where a finger of ice had thrust through a notch in the rocky hill indicating an ice approach almost to the edge of the water there. The scablands on granite and schists on the south side of Spokane Valley from Coeur d' Alene

to Spokane might indicate only marginal flow of water around the ice front in the valley. Ice rafted boulders in pleistocene "Lake Spokane" were traced to much higher levels than hitherto found along the entire south side of the valley and to the south and west side of Lake Coeur d'Alene. The upper limit of these was shown to reach that at which Hershey found his boulders at Kellogg, for the first time definitely correlating those observations made in 1912 (Hershey Bull. G. S. A. No. 23.) with "Lake Spokane." new evidence of southward flow through the Mica Outlet of Lake Spokane was found in gravels about two miles north of the village of Mica.

It has previously been assumed that ground ice must have impinged against the Palouse hills at Spangle in order to have caused the overflow from Hangman Creek valley into North Pine Creek (causing the N. Pine scablands). However, prior to the flood erosion, these hills may have been much nearer to Spokane and formed the necessary barrier to operate the Pine Creek Channel before the erosion between Cheney and Spangle. Positive evidence was found, however, of ground ice in the lee of the quartzite hill known as Brown's Butte, six miles south of Spokane on the west side of Hangman Creek near the Inland Highway. This may mark the farthest advance of ice crossing the Spokane townsite. The North Hill of Spokane otherwise Lidgerwood Terrace is correllated with gravels from Rathdrum to Spokane and on down the Spokane River and northward around Five Mile Prairie, indicating a valley till from the east to that level. This may necessitate revision of some conclusions, of Large regarding a delta of Pend Oveille River at the time of its southward flow from "Lake Clark" at Newport. More nearly related to the problem of the "Spokane Flood" are the observations that the morainic material lying on prairies surrounding Spokane from which the "Spokane Glaciation" received its name must have succeeded the "flood" otherwise it would have been washed away. This observation will necessitate reviewing several papers in this connection. It should be remembered that ice lobes in the glacial period were not continuous in maintainance of their border in advance or retreat. Weather or climatic changes seem to have caused oscillations but our records are only of the recessional stages after the greatest advance. All others are lost in the ground moraine. The significance of Dr. Bretz observation then is that the Spokane flood occurred in the period of recession. This is precisely what should be expected if the source of water was ice impounded water.

The main work of the Chicago party in the past two years has been tracing the "backwash" effects in valleys tributary to those through which this flood advanced. In 1928 valleys of the east and south side of the scablands area were examined. This season those were reexamined and effects traced much farther up stream and in addition the valleys of the west side were examined. Concerning his work on the east side he says: "We found considerably more evidence in the valleys east of the scabland, of the enormous backwash which is the subject of my latest paper. Some of this was clear up the Clearwater, 25 miles beyond Lewiston; some was as near Spokane as Mt. Hope. I have found it consistently true that every valley I entered in this part of the Palouse country has the same extraordinary records of backwash up to the upper limits of the scabland flood immediately to the west. We have had simply no failure yet in applying this criterion. The material is never higher and invariably is present within the proper limits. I consider this to be of extreme significance." Some very in-

teresting relations of gravels from Grand and Moses Coulees to glacial moraines below Wenatchee must in fairness wait for Dr. Bretz own publication, as must his work in the Yakima Valley. The following quotation will be highly interesting and apparently not in any way be a premature statement of matters best left to Dr. Bretz own particularized announcements:

"We found just outside the mouth of Yakima valley on the east slope of the Rattlesnake Mountains some very surprising berg deposits. They constituted mounds 100 feet or so in diameter and 10-20 or even 30 feet high; mounds that are composed of glacial drift lying on the Ringold terrace at this place. They are sepearate mounds, spaced rather widely but a dozen or twenty being visible from almost any viewpoint. The material of these mounds was largely granite but second in importance certainly was the Belt metamomrphic material of Northern Idaho and Northwestern Montana. There was also a good scattering of the grano-diorite porphyry which I have been finding all over the area affected by the Spokane flood. Furthermore there was almost no gneiss, though if the bergs which brought this debris to this place had come from the breaking up of the Okanogan lobe, the Shuswap gneiss would have been very prominent indeed. Since the home of the grano-diorite is apparently on the east side of Lake Pend Oreille, according to Anderson at any rate, it and the Belt metamorphics indicate that great masses of berg ice were carried from areas east of the state of Washington across to strand on the west side of the Columbia, north of the mouth of the Yakima."

It is quite probably that many who have listened to this paper do not fully grasp how highly controversial and indeed almost revolutionary are these results presented by Dr. Bretz. Also many people not familiar with the requirements of scientific proof may imagine that in order to do work of this character and have it recognized and accepted as a truthful account of events in the dim past, one has only to ride about and look at the hills and dream pleasant dreams. An acquaintance with the severity of the criticism directed against the work of Dr. Bretz on the Channelled Scablands and The Spokane Flood would correct all such ideas. There was a time in the early study of geology when all geologic processes were considered "catyclismic" as a necessity for accomplishment of vast effects in a limited time at the disposal of the geologist. But with the revision of time-concepts has come a view that practically all processes of earth making are the slow, almost inperceptible changes as we now ordinarily see them in progress. So thoroughly has this idea taken effect that practically all geologists now eliminate the spectacular from concepts, with which they deal. When Dr Bretz sprung the idea of sudden flood as the means of removal of 2800 square miles of Palouse and Big Bend soil to a depth of 150 to 200 feet, leaving the central portion of the State of Washington scarred with vast areas of ragged rock-bottom channels of widths from one to thirty miles, the conservative ones were amused and smiled at this "locomotive in breeches" from Chicago who was rushing about in the terrific summer heat and cooking up such brainstorms.

Conversation with some is an occupational necessity. Ultra-progressives and revolutionists are not to be trusted with serious responsibilities where vast important interests are are stake. The commonplace mind is safer. But such finds itself helpless in the presence of unheard of phenomena. In this instance in their social intercourse and in professional meetings of kindred spirits they gently "spoofed" this wild man and wrote poetry and sang songs about his "Spokane Flood." In a meeting when he was present he was badgered, not with field

evidence but with smug theories. Some of his critics had never been within two thousand miles of this utterly unique thing. The printed report of this meeting recalls the trial of Galileo. Here was a heretic. They took turns in testing him with their own orthodoxy. He defied them to go to the field and test their theories there. Other geologists have done so. They have found a thing the like of which has occurred nowhere else in the world. This wild man does not seem so wild. We await with interest the findings of his critics. They can scarcely ignore the challenge.

A PLANT DISEASE MYSTERY SOLVED*

F. D. Heald

Head Dept. Plant Pathology, State College of Washington

The plant doctors, like the members of the medical profession, have had numerous diseases to contend with from time to time which have baffled all the efforts of investigators in discovering their cause and also in working out practical and effective methods of prevention or control. A disease of the tomato that has been a constant menace to the culture of this crop ever since it has been grown west of the Rock Mountains is an outstanding illustration. The disease in question was first referred to most frequently as "tomato blight", a term which is, as we now know, a very indefinite one, since there are many kinds of diseases which blight or blast the foliage of plants. Many other common names have been applied to the disease such as summer blight, yellow blight, western blight, western yellow blight and more recently tomato yellow, and tomato curly top. It is probable that nearly everyone who has grown tomatoes either commercially or in the home garden in almost any section west of the Rocky Mountains has at some time seen this destructive disease wipe out either a small percentage of the crop of in seasons of maximum severity even the entire planting before maturity was reached.

At this point it way be well to present a brief description of the symptoms and effects of this disease in order that we may have before us a fairly clear picture. Confining our attention to the disease as it appears upon plants that are mature or approaching maturity, the deviations from the normal may be noted. The following are the most prominent effects upon the aerial parts of the plant:

1. Curling or rolling of the leaflets.
2. Discoloration of the foliage, either a general pallor with more or less yellowing or localized yellowing, and even in many cases a purple coloration especially of the veins. In some cases the yellowing and purpling may be preceded by a gravish sheen of the affected foliage which is quite characteristic.
3. Dwarfing or reduction in size of the entire top.
4. A harsh and rigid feel of the foliage as compared to that of the normal plant.
5. Reduction in size of the fruit and premature ripening or failure to set any fruits.
6. Wilting and death of the entire top, which in most cases does not reach this culmination until fruit of some size has been formed.

If seriously affected plants are examined abnormal changes in the root system may also be noticed:

1. The death of the fibrous roots from the tip backward.

*Original contribution.

2. The presence of dead or corroded areas upon some of the larger roots.

3. An abnormal production of fibrous roots from the base of the stem. While this condition is common it is not a constant character.

A typical picture would be an undersized plant, with rolled or curled, rigid or harsh, leaflets, showing more or less yellowing and sometimes tinges of purple, followed later by premature reddening of the undersized fruit and browning and final death of the foliage.

One of the strange features about tomato blight has been its peculiar geographical distribution. It is known to occur throughout most of the regions west of the Rocky Mountains from British Columbia to Mexico. It has been especially severe in the hot, semi-arid, irrigated valleys from Lake Okanogan south through Washington, Idaho, Oregon, Utah, and California. In Washington, the Okanogan, Wenatchee, Yakima, Columbia, and Snake River Valleys have experienced the most severe attacks while in the higher elevations of the Palouse Country and the cooler regions of the Coastal belt, the attacks have been more moderate and less destructive. Some years ago attempts were made to reproduce the tomato blight in Wisconsin by using soil shipped from Washington, but all efforts were without success. Why this disease has been confined to the Pacific Coast remained a mystery until the cause was discovered a few years ago.

The western blight or yellows of tomato has occupied a place in the agricultural and scientific press of Pacific Coast states at least for the last 36 years. In 1893 it was recognized as a problem by the Agricultural Experiment Station of Washington as may be noted from the Annual Report for that year, in which work was planned for the following year on "Investigations into the cause of tomato blight and experimenting with remedies for the same". Despite continued studies by workers in the various states of the Pacific Coast, the cause of the disease and methods for its control had remained a mystery until the summer of 1927, when the first part of this perplexing puzzle was solved.

It will be well to present a brief statement as to the recognized classes of plant diseases before discussing the work which lead up to a discovery of the cause of tomato blight. There are three general classes of plant diseases according to the nature of the casual agents:

1. *Non-Parasitic disturbances,* resulting for example, from improper conditions of soil or air.

2. *Parasitic troubles,* caused by the inroads of other organisms, such as bacteria, fungi or other parasites which live at the expense of their hosts and cause slight or grave disturbances in their life processes.

3. *Virus diseases,* due to an infectious principle, a so-called virus, which can be transmitted from diseased to healthy plants, generally by the feeding punctures of some insect carrier or vector.

Various theories have prevailed as to the cause of the western blight of the tomato since it has been the subject of investigation. It was first thought to be caused by a parasite of some sort as is evidenced by the fact that records of spraying experiments with various fugicides may be found in some of the early reports. When these tests yielded no results and no fungi could be found on or in the foliage of diseased plants, attention was next directed to bacteria as the possible causal agents. Again there was failure, for the various bacteria could not be made to reproduce the disease.

This was as far as our knowledge had advanced until Smith working in California (in 1906) and Humphrey in Washton (in 1912-14) presented reports which pointed to the attacks of a soil fungus (Fusarium) upon the root system as the true cause. The writer who

began work on the disease in 1915 accepted this theory as plausible, but rather extensive field observations pointed to another soil fungus, the common Rhizoctonia, the cause of our well-known Rhizoctonia disease of potatoes, as the root parasite. In later years both species of fungi were used in numerous field tests but failure to reproduce the disease with these fungi left us again in the dark as to the cause.

The failure to find any parasite either on the foliage or on the root system that could be definitely connected with the disease as its causal agent, led to another theory, namely that the disease was a non-parasitic type, resulting largely from a peculiar climatic complex, one of the most striking features of which was a very high evaporation resulting in a very low humidity of the air. Quoting from the author of this theory, this condition "in the presence of other not yet fully understood factors" was the suggested cause as recently as 1926. Previous to this time the writer and his associate had arrived at another conclusion as may be noted from a quotation from the Annual Report for the Washington Argicultural Experiment Station of 1922: "The behavior of diseased plants and the outcome of previous experimental work has suggested that this disease is one of the virus troubles." It may be noted then that during these years of struggle for a solution of the puzzle, the disease had successively been assigned to each one of the three groups of plant diseases.

The first definite clue to the cause of western blight or yellows of the tomato was obtained during the summer of 1927. During that season there was an unusual prevalence of the curly top of sugar beets and tomato blight in Washington, Oregon, and Utah, and whenever one of these diseases was severe in a locality, the other was also severe. This pronounced correlation in the prevalence of the two diseases led to the supposition that they were caused by the same agencies. The curly top of the sugar beet had long been recognized as a trouble of the virus type, caused by the feeding punctures of a small sucking insect known as the beet leaf hopper (Eutettix tenella). With this suggestion the solution was comparatively simple, and was first presented by the work of McKay of Oregon. Leaf hoppers from curly top beets were pastured on tomato plants and typical tomato blight was the result. These results have since been confirmed by other works in the Pacific Coast states and the typical curly top of beets induced by leaf hoppers from blighted tomato plants. It has therefore been definitely established that tomato blight is a disease of the virus type, caused by the same virus as the curly top of sugar beets and transmitted by the feeding punctures of the beet leaf hopper and by no other means. For this reason it has been suggested that the disease should be called the tomato curly top.

This definite establishment of the cause of tomato blight will explain a number of facts that were previously obscure: 1, the known range of occurrence of tomato blight which paralleles the geographic distribution of the beet leaf hopper; 2, the greatest severity of tomato blight in the semi-arid, irrigated valleys having a very high evaporation, just the regions in which the beet leaf hoppers seem to thrive and frequently are found in enormous numbers.

It probably will be no great consolation to the tomato grower to know that the tomato blight or curly top of his garden or field is caused by a virus transmitted by an insect over which he can have little or no control, and that the severity of the disease may be expected to fluctuate in accordance with the abundance of this insect. It is known that many wild species, of plants may harbor the virus of curly top and that leaf hop-

pers migarting from these infected plants may bring the disease into our cultivated fields, not only to the tomato but to various other cultivated plants, such as beets, beans, squash, and various garden ornamentals, being especially severe on hosts other than beets and tomatoes only in epidemic years.

Now that the first part of our mystery has been solved, and the cause of tomato blight definitely established, the next efforts must be directed toward control. The outlook, however, is not very promising. First it may be noted that all efforts in the control of leaf hoppers on beets and tomatoes by the use of either repellants or contact sprays have been of little value. While it has been noted that late planting and partial shading of tomatoes have had some effect in reducing losses from blight, the results are uncertain. The principal hope seems to lie in the production resistant or immune varieties and work along this line is underway in a number of our Experiment Stations.

Separates of a recent paper by Mr. I. T. Haig on "Accuracy of Quadrat Sampling in Studying Reproduction in Cut-Over Areas" which appeared in a recent number of Ecology have bee presented to the publishers of NORTHWEST SCIENCE through the courtesy of Mr. Haig.

Copies may be secured by applying to the Secretary-Treasurer of the Association.

TWO SERIOUS ERRORS have occurred in recent numbers of NORTHWEST SCIENCE, the first being in the June, issue with the failure to print the concluding paragraphs of "Economical Distribution of Steam," by Prof. A. C. Abell, Apology for this delinquency brought this reply: "I would make the following suggestion: that a notice of some sort be included in Northwest Science in an early issue to the effect that through some oversight the complete article was not included but that this complete article will appear in an Engineering Bulletin in the very near future and those that desire a copy of this bulletin may obtain same by addressing the Dean of Engineering at the State College of Washington!"

The second error was in the September issue in connection with the article on "Application of Polarized Light to Metallagraphy", by Prof. R. C. Treasher, where the "Figures" were reversed.

L. K. Armstrong, Editor

INSTITUTIONAL MEMBERSHIP

E. A. BRYAN*

It will be recalled that one of the very important actions of the 1928 session of the Northwest Scientific Association was the establishment of three new types of membership—Institutional, Life and Supporting. Thus far a good beginning has been made in each of the three States, Montana, Idaho and Washington, in Institutional Memberships. These being annual are especially important and every institution within the territory to which the Northwest Scientific Association appeals should enroll. I recall the period when in 1887 the Indiana Academy of Science was organized with David Starr Jordan as its first president. The work of that organization has been monumental. But far more important has been its inspiration to a multitude of scientists whose youthful aspirations were by it guided into the paths leading to scientific achievement. Directly and indirectly every member of the Northwest Scientific Asociation should stir up the institution with which he is connected to membership in the organization.

*Research Professor of Economic History State College of Washington and Chairman of Institutional Membership Committee of the Northwest Scientific Association.

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OF THE
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December 27-28, 1929
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State Normal School, Cheney, Washington

REDUCED RATES FOR MEETING

A convention certificate will be sent to each member who resides outside the city of Spokane. This certificate, if presented to railroad agents at starting point, will entitle members to a round trip fare of one and one half times the regular one way fare. Certificates may be presented December 24 to December 28. Return limit is January 1st. There will be, in addition to these rates, the special Christmas rates of fare and a third. Members using the latter, will however, have to leave their starting point not later than December 25.

MEMBERSHIP

Membership is open to any one paying the annual dues of one dollar. Members receive without additional cost the issues of Northwest Science, the official publication of the Association.

HEADQUARTERS

The Davenport Hotel will be the headquarters of the Association and all meetings will be held in the hotel rooms.

REGISTRATION

The registration desk will be found on the Mezzanine floor of the Davenport Hotel. All old members should register and receive their official badge for the meeting. At the same time they should see that their dues are paid for 1930. New members should fill out an application blank and pay the annual dues. Visitors are requested to register and secure a visitor's badge.

Registration will begin at 9:00 A. M., December 27 and continue until the following noon. All are urged to register as early as possible.

ANNUAL DINNER
Luncheons—Breakfasts

The annual dinner will be held at 6:30 P. M. Friday, December 27, in the Elizabethan Rooms. Tickets should be purchased at the time of registration. Price, $1.50. Members and guests are invited to attend. The address of the evening will be given by E. A. Bryan, Retiring President of the Association. Subject "The Present Status of Scientific Education: How it Came to Pass".

A luncheon of the Association will be held on Saturday, December 28, in the Elizabethan Rooms. Price seventy five cents. R. T. Hargreaves, President of

the State Normal School, Cheney, Washington will speak. Subject: "Science and Education."

The society of Xi Sigma Pi, national forestry honorary society, will hold its annual national convention in connection with the meetings of the Northwest Scientific Association. There will be a luncheon for members of the society and their guests on Friday, December 27, in the East Banquet Hall. Price seventy five cents.

There will be a Sigma Xi breakfast for members and guests on Saturday morning at 8:00 o'cock in the East Banquet Hall. Reservations may be made at the registration desk until Friday evening. Price seventy five cents.

A Phi Delta Kappa breakfast for members and guests will be held on Saturday morning at 8:00 o'clock in Room 200. Reservations may be made at the registration desk until Friday evening. Price seventy five cents.

CONDENSED SCHEDULE OF ALL MEETINGS

Friday, December 27

9:00 A. M.—Registration, Mezzanine Floor

10:00 A. M.—General Session. Elizabethan Rooms A, B, C.

2:00 P. M.—Section Meetings

Botany-Zoology. Elizabethan B, C.
Chemistry-Physics. Elizabethan D, E.
Education. Room 200.
Engineering. Elizabethan A.
Forestry. East Banquet Hall.
Geology-Geography. Mandarin Room.
Plant Pathology. Tent C.
Social Science. Hall of the Doges.

3:30 P. M.—General Session. Medical Program. Elizabethan Rooms A, B, C.

6:30 P. M.—Annual Dinner. Elizabethan Rooms.

Saturday, December 28

9:00 A. M.—General Session. Business Meeting. Elizabethan A, B, C.

10:30 A. M.—Section Meetings

Botany-Zoology. Elizabethan A.
Chemistry-Physics. Elizabethan D. E.
Forestry. Elizabethan B, C.
Geology-Geography. Room 200.
Plant Pathology. Tent A.
Social Science. Tent C.

12:00 Noon—Luncheon. Elizabethan Rooms.

2:00 P. M.—Section Meetings.

Bontany-Zoology. Elizabethan B, C.
Chemistry-Physics. Elizabethan D, E.
Education. Tent C.
Engineering, Elizabethan A.
Forestry. Mandarin Room.
Geology-Geography. East Banquet Hall.
Plant Pathology. Room 200.
Social Science. Hall of the Doges.

GENERAL SESSIONS

10:00 A. M.—Elizabethan Rooms A, B, C. President J. A. Kostalek presiding. Symposium: The Encouragement of Research by Institutions of Higher Learning in the Northwest.

Charles H. Clapp, President University of Montana, Missoula.
Ernest O. Holland, President State College of Washington, Pullman.
M. F. Angell, University of Idaho, Moscow.

3:30 P. M.—Medical Program. Elizabethan Rooms A, B, C.

Dr. S. E. Lambert, Spokane, Washington, Chairman.
Dr. R. E. T. Stier, Spokane, Washington, Secretary.

1. Vitamins; Their Source and Functions—Dr. E. J. Barnett, Spokane, Washington.
2. Ductless Glands—Dr. I. S. Collins, Spokane, Washington.
3. Myopia—Dr. R. J. Sprowl, Spokane, Washington.
4. Our Increased Heart and Blood Vessel Mortality—Dr. Donald A. Palmer, Spokane, Washington.
5. Preservation of Hearing—Dr. F. C. Harvey, Spokane, Washington.

6:30 P. M.—Annual Dinner
Elizabethan Rooms.
President J. A. Kostalek, Chairman.
Address of retiring president, E. A. Bryan, State College of Washington, Pullman. Subject: "The Present Status of Scientific Education: How It Came to Pass."

Saturday, December 28

9:00 A. M.—Annual Business Meeting.
Elizabethan Rooms, A, B, C.
President J. A. Kostalek, Chairman.
Reports of Officers and Committees.

Election of Officers.

12:00 Noon—Luncheon
Elizabethan Rooms.
Address: "Science and Education"—R. T. Hargreaves, President State Normal School, Cheney, Washington.

SECTIONAL MEETINGS

Friday and Saturday, December 27-28

---- .... Botany-Zoology ....

T. A. Bonser, North Central High School, Spokane, Washington, Chairman.
D. J. Leffingwell, State College of Washington, Pullman, Secretary.

FRIDAY, 2:00 P. M.
Elizabethan Rooms B and C.

1. The Question of Mitosis—
H. B. Stough, University of Idaho, Moscow. 20 Minutes.
2. The Characteristics and Utilization of Northwestern Peat Soils—
W. L. Powers, Oregon State College, Corvallis. 15 Minutes.
3. New Records for Glacier Park—
Nettie M. Cook, Lewis and Clark High School, Spokane, Washington. 20 Minutes.
4. The Starch Method for Study of the Transpiration Stream—Robert E. Hungate, Stanford University, Palo Alto, California. 15 Minutes

SATURDAY, 10:30 A. M.
Elizabethan Room A.

1. The Effect of Alkalinity of the Soil on Osmotic Pressure and pH Values of the Tissue Fluids of Sweet Clover and Corn—
Floyd W. Gail, University of Idaho, Moscow. 15 Minutes.
2. Plant Collections Near Weippe, Idaho—
Nettie M. Cook, Lewis and Clark High School, Spokane, Washington. 30 Minutes
3. The Drought—Resistant Bulb of the Wild Onion, Allium acuminatum Hook.
L. A. Mullen, State College of Washington, Pullman. 15 Minutes.

SATURDAY, 2:00 P. M.
Elizabethan Rooms B and C.

1. Election of Officers.
2. Preliminary Report on the Algae of of Northern Idaho—
R. A. Diettert, University of Idaho, Moscow. 20 Minutes.
3. Genetics of Ridit Crosses—
Karl B. Daniloff, State College of Washington, Pullman. 15 Minutes.
4. Studies of the Survival of Extreme Desiccation by Plants—
F. L. Pickett, State College of Washington, Pullman. 10 Minutes.
5. The Resumption of Activities by Certain Xerophytic Mosses After Long Periods of Drought.
Elizabeth McKay, State College of Washington, Pullman. 5 Minutes.

Chemistry-Physics

B. L. Steele, State College of Washington, Pullman, Chairman.
J. L. Slonaker, North Central High School, Spokane, Washington, Secretary.

FRIDAY, 2:00 P. M.
Elizabethan Rooms D and E.

1. Improved Hydrogen Electrode Apparatus—
W. B. Bollen, University of Idaho, Moscow. 10 Minutes.
2. A New Magnetometer for the Study of Iron and Steel—
H. V. Carpenter, State College of Washington, Pullman. 10 Minutes
3. A Direct Reading Spherometer—
W. L. Bond, New York City. 10 Minutes.
4. A Study of the Relation Between Surface Tension and Anaesthetic Activity—H. L. Cole, State College of Washington, Pullman. 10 Minutes.
5. A Travelling Wave Apparatus—B. L. Steele and Ralph Schlichtig, State College of Washington, Pullman. 15 Minutes.
6. A Modern Spectroscopic Method Applied to Indium—
G. W. Hammer, University of Idaho, Moscow. 10 Minutes.
7. Preparation of Telluric Acid— L. I. Gilbertson, State College of Washington, Pullman. 10 Minutes.
8. Titration of Borates, Using Mucic Acid—A. W. Martin, University of Idaho, Moscow. 10 Minutes.

SATURDAY, 10:30 A. M.
Elizabethan Rooms D and E.

1. Some Aliphatic Compounds of Selenium—W. E. Bradt and M. Van Valkenburgh, University of Cincinnati, Cincinnati, Ohio. 10 Minutes.
2. Electrometric Titration of Lead— R. W. Gelbach and K. G. Compton, State College of Washington, Pullman. 10 Minutes.
3. Drifts in Potential of the Hydrogen Electrode—W. B. Bollen, University of Idaho, Moscow. 10 Minutes.
4. The Variation of the Photo-Electric Sensitivity of Tantalum With Heat Treatment—C. W. Eckels, State College of Washington, Pullman. 10 Minutes.
5. Colloidal Bound Water—J. L. St. John, State College of Washington,

Pullman. 10 Minutes.

6. Effect of Gases on Stability of Metallic Sols—W. H. Cone, University of Idaho, Moscow. 10 Minutes.
7. The Diffusion of Copper in Alkaline Systems—V. L. Ricketts and J. L. Culbertson, State College of Washington, Pullman. 10 Minutes
8. Ethylene Oxide and Some Grignard Reagents—A. G. Cole, State College, of Washington, Pullman. 10 Minutes.

SATURDAY, 2:00 P. M.

Elizabethan Rooms D and E.

1. Election of Officers.
2. Easy Way of Finding the Distance to the Moon—Benjamin H. Brown, Walla Walla, Washington. 15 Minutes.
3. Some Derivatives of Diphenyl Oxide —C. A. Doran, State College of Washington, Pullman. 10 Minutes
4. A Modification of the Boiling Point Method for Determining Molecular Weight—C .L. von Ende, University of Idaho, Moscow. 10 Minutes.
5. Alkylation of Halogenated Metal— J. C. Harris, State College of Washington, Pullman. 10 Minutes.
6. The Bernoulli Equation and the Velocity of Transmission of Pressure Energy—Thomas M. Dahm, University of Idaho, Moscow. 10 Minutes
7. Ozonides of O-Xylene and the Constitution of the Benzene Ring— A. A. Levine and A. G. Cole, State College of Washington, Pullman. 20 Minutes.
8. A New Thermostat Regulator—W. H. Cone, University of Idaho, Moscow. 10 Minutes.
9. An Investigation of the Source of Light in the Arago Bright Spot—A. C. Mahaffay, State College of Washington, Pullman. 10 Minutes.

Education

I. N. Madsen, State Normal School, Lewiston, Idaho, Chairman.
S. G. Witter, Part Time School, Spokane, Washington, Secretary.

FRIDAY, 2:00 P. M.

Room 200.

1. Some Experiments with Hypnotism— E. A. Atkinson, University of Montana, Missoula. 20 Minutes.
2. Research Studies in College Teaching—C. W. Stone, State College of Washington, Pullman. 15 Minutes.
3. The Use of Stenographic Notes in Supervision—John W. Goddard, State Normal School, Cheney, Washington. 15 Minutes.
4. The Effect of Reading Ability and Accuracy on Correlation of School Subjects as Indicated by Objective Test Scores—Raymond F. Hawk, State Normal School, Cheney, Washington. 20 Minutes.
5. Reading of High School Students— W. F. Standeford, Superintendent of Schools, Burke, Idaho. 20 Minutes.
6. Science Versus Dogma—Rev. Charles Pease, Spokane, Washington. 15 Minutes.

SATURDAY, 2:00 P. M.

Tent Room C.

1. Election of Officers.
2. Leadership Qualities of Superintendents of Schools—Robert E. McConnell, State Normal School, Cheney, Washington. 20 Minutes.
3. Taxation in the Public Schools of Washington—O. C. Pratt, Superintendent of Schools, Spokane, Washington. 30 Minutes.
4. How to Interpret the Coefficient of Correlation—P. H. Nygaard, North Central High School, Spokane, Washington. 15 Minutes.
5. Disease Experience of School Children—W. F. Standeford, Superintendent of Schools, Burke, Idaho. 20 Minutes.

Engineering

Homer J. Dana, State College of Washington, Pullman, Chairman.
Charles B. Carpenter, Washington Water Power Company, Spokane, Washington, Secretary.

Friday, 2:00 P. M.

Elizabethan Room A.

1. A Discussion of the Theoretical Design of Riveted Joints for Pressure Vessels, With Proposed Empirical Formula—H. F. Gauss, University of Idaho, Moscow. 15 Minutes.
2. Compensated Power Lines—H. V. Carpenter, State College of Washington, Pullman. 10 Minutes.
3. First Progress Report on Costs of Residential Heating With Automatic Oil Furnaces—F. W. Candee, State College of Washington, Pullman. 15 Minutes.

SATURDAY, 2:00 P. M.

Elizabethan Room A.

1. Election of Officers.
2. Prevention of "Washboarding" of Gravel Highways — Homer J. Dana, State College of Washington, Pullman. 15 Minutes.
3. A Field Study of Crazing in Pre-Casting Building Stone—Jesse E.

Buchanan, University of Idaho, Moscow. 15 Minutes.

4. Can Concrete be Considered Elastic Along With Other Materials of Construction?—H. H. Langdon, State College of Washington, Pullman. 15 Minutes.

Forestry

R. H. Weidman, Northern Rocky Mountain Experiment Station, Missoula, Montana, Chairman.

I. T. Haig, Northern Rocky Mountain Experiment Station, Missoula Montana, Secretary.

FRIDAY, 2:00 P. M.
East Banquet Hall.
Forest Protection Symposium.

1. Announcement of Purpose and Scope of Symposium-Chairman.
2. Fire as a Factor in the Management of Northern Idaho National Forests —H. R. Flint, Missoula, Montana. 20 Minutes.
3. Some Aspects of Private Forest Fire Protection—T. C. Spaulding, University of Montana, Missoula. 15 Minutes.
4. How Dangerous are Dry Lightning Storms?—H. T. Gisborne, Northern Rocky Mountain Experiment Station Missoula, Montana. 10 minutes.
5. Some 1929 Fire Weather Comparisons—E. M. Keyser, U. S. Weather Bureau, Spokane, Washington. 20 Minutes.
6. The Role of Pathology in Forest Protection—E. E. Hubert, University of Idaho, Moscow. 20 minutes.

SATURDAY, 10:30 A. M.
Elizabethan Rooms B and C

1. Election of Officers.
2. Northern Idaho's Forestry Future—What Will it be?—E. H. Myrick, U. S. Forest Service, St. Maries, Idaho. 20 Minutes.
3. The Idaho Reforestation Law—F. G. Miller, University of Idaho, Moscow. 10 Minutes.
4. The Value of Salt on Alkali Ranges in the Forests of South-eastern Montana—T. Lommasson, U. S. Forest Service, Missoula, Montana. 10 Minutes.

SATURDAY, 2:00 P. M.
Mandarin Room.
Continuation of Forest Protection Symposium.

1. Development of Blister Rust Control in the Far West—S. N. Wyckoff, Western Office of Blister Rust Control, Bureau of Plant Industry, Spokane, Washington. 20 Minutes
2. Economic Status of Forest Insects in the Northwest—J. C. Evenden, Forest Insect Field Station, Bureau of Entomology, Coeur d' Alene, Idaho. 15 Minutes
3. Studies Leading to Improved Methods of Bark Beetle Control—A. L. Gibson, Forest Insect Field Station, Bureau of Entomology, Coeur d' Alene, Idaho. 10 Minutes.

Geology——Geography

Alfred L. Anderson, University of Idaho, Moscow, Chairman.

Eugene S. Perry, State School of Mines, Butte, Montana, Secretary.

FRIDAY, 2:00 P. M.
Mandarin Room.

1. Correlation of the Belt Rocks—Charles H. Clapp, President, University of Montana, Missoula. 20 Minutes
2. Rock Glaciers in the Mountains Near Clayton—Thomas H. Hite, University of Idaho, Moscow. 20 Minutes
3. Mining as a Business—Russell F. Collins, Spokane, Washington, 15 Minutes
4. The Flathead Mine and Mining District, P. J. Shenon, State School of Mines, Butte, Montana, 20 Minutes
5. A New Rainfall Map of Washington —O. W. Freeman, State Normal School, Cheney, Washington. 10 Minutes
6. Origin of the Kamiak Asbestos—Alfred L. Anderson, University of Idaho, Moscow. 15 Minutes

SATURDAY, 10:30 A. M.
Room 200.

1. Pantops, an Unusual Moraine—Thomas Large, Lewis and Clark High School, Spokane, Washington. 10 Minutes
2. Ground Water in Eastern Montana —Eugene S. Perry, State School of Mines, Butte, Montana. 20 Minutes
3. Geologic Features of the Snake River Canyon—F. B. Laney, University of Idaho, Moscow. 30 Minutes
4. Eruptives of the Coeur d' Alene District—J. H. Eby, Spokane, Washington. 20 Minutes
5. Human Relationships of Scab Land Mounds—O. W. Freeman, State Normal School, Cheney, Washington. 10 Minutes

SATURDAY, 2:00 P. M.
East Banquet Hall.

1. Election of Officers.

2. Belt Rocks in Northern Idaho—Alfred L. Anderson, University of Idaho, Moscow. 25 Minutes
3. Landslide Topography Along the Clearwater River — Andrew H. Thomson, University of Idaho, Moscow. 15 Minutes

4.a. Correlation of Pleistocene "Lake Spokane" with Hershey's Ice-Rafted Boulders Near Kellogg, Idaho.

b. The Lake Pend Oreille "Spigot" and Pleistocene Floods.

c. Topography Reversals at the Northern Margin of the Columbia Basalt.

Thomas Large, Lewis and Clark High School, Spokane, Washington. 10 Minutes

5. The Kevin-Sunburst Oil and Gas Field—Eugene S. Perry, State School of Mines, Butte, Montana. 20 Minutes

Plant Pathology

H. E. Morris, Montana State College, Bozeman, Chairman.

Leon K. Jones, State College of Washington, Pullman, Secretary.

FRIDAY, 2:00 P. M.
Tent Room C.

1. Organisms Associated with Decay in Apples—George D. Ruehle, State College of Washington, Pullman. 20 Minutes
2. The Use of Fungi in Certain Commercial Processes—E. E. Hubert, University of Idaho, Moscow. 15 Minutes
3. The Effect of Rust on the Formation of Anthocyanin Pigments in Leaves—Charles W. Waters, University of Montana, Missoula. 15 Minutes
4. Tip-Burn of Lettuce as Related to Slime—George A. Newton, Experiment Station, Puyallup, Washington. 10 Minutes

SATURDAY, 10:30 A. M.
Tent Room A.

1. Virus Diseases of Raspberries in Washington—Leon K. Jones, State College of Washington, Pullman. 20 Minutes
2. Early Spring Blight of Wheat Caus- Renisberg and C. W. Hungerford, University of Idaho, Moscow. 15 Minutes
3. Abnormal Development in Smutted Heads—W. K. Smith, State College of Washington, Pullman. 10 Minutes ed by **Sclerotium fulvum** Fr.—Ruth
4. Bean Mosaic Resistance in the Great Northern Variety—W. H. Pierce, University of Idaho, Moscow. 15 Minutes

SATURDAY, 2:00 P. M.
Room 200.

1. Election of Officers.
2. Blight of Stone Fruits Caused by **Coryneum beijerinckii** Oud.—Earle C. Blodgett and C. W. Hungerford, University of Idaho, Moscow. 15 Minutes
3. The Effect of "Streak" on Yield of Greenhouse Tomatoes—Leon K. Jones, State College of Washington, Pullman. 20 Minutes
4. Federal Plant Quarantine Enforcement—C. R. Stillinger, Plant Quarantine and Control Administration, U. S. Department of Agriculture, Spokane, Washington. 10 Minutes
5. Tests on Gas Grain Treater for the Control of Smut—J. Kienholz and W. K. Smith, State College of Washington, Pullman. 10 Minutes

Social Science

James G. Patrick, Spokane University, Spokane, Washington, Chairman.

Louis S. Livingstone, Lewis and Clark High School, Spokane, Washington, Secretary.

FRIDAY, 2:00 P. M.
Hall of the Doges.

1. Traits of Political Leadership—Claudius O. Johnson, State College of Washington, Pullman. 30 Minutes
2. The Relations between Early Pioneer Missionaries of the Northwest —George F. Weibel, S. J., Gonzaga University, Spokane, Washington. 30 Minutes

SATURDAY, 10:30 A. M.
Tent Room C.

1. Election of Officers.
2. Origins of Extra Territoriality in China—Earl Pritchard, State College of Washington, Pullman. 30 Minutes
3. Jason Lee's Part in the Founding of the Commonwealth of Oregon—C. J. Brosnan, University of Idaho, Moscow. 20 Minutes.

SATURDAY, 2:00 P. M.
Hall of the Doges.

1. A Typical Hydro-Electric Development of the Pacific Northwest—E. A. Bryan, State College of Washington, Pullman. 30 Minutes
2. Are the Brightest Young Men and Women Leaving the Farm?—F. R. Yoder, State College of Washington, Pullman. 15 Minutes

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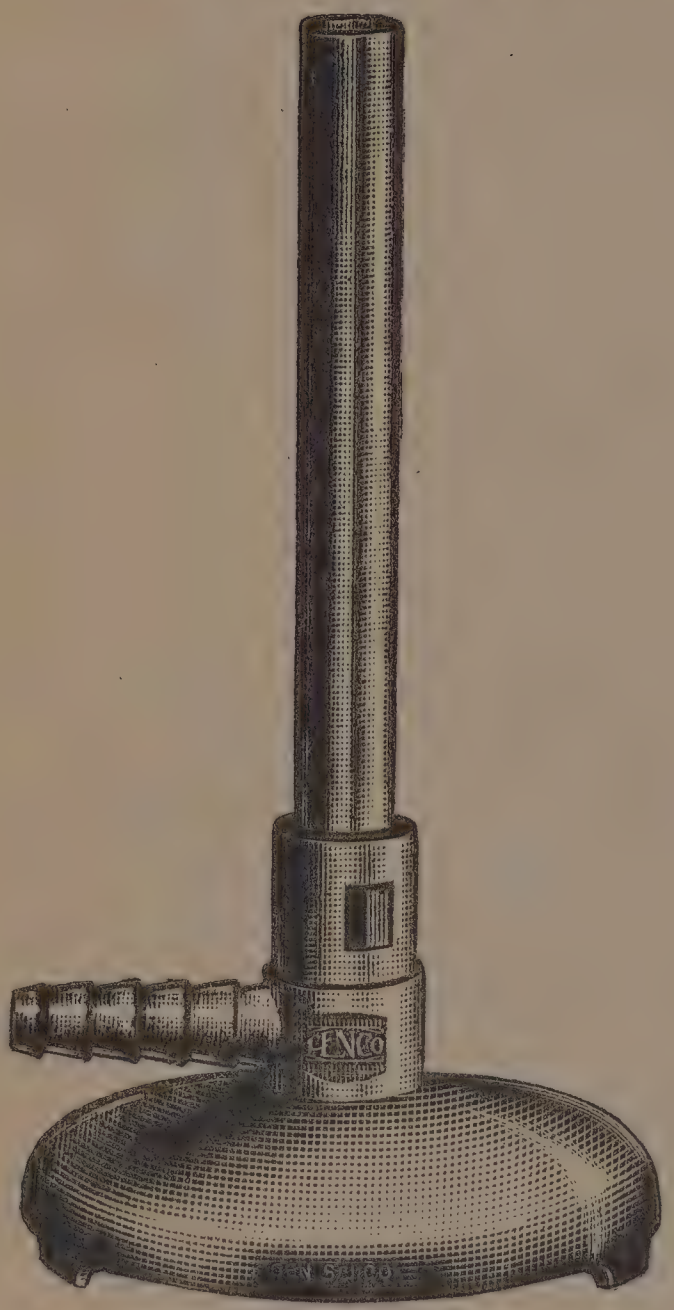

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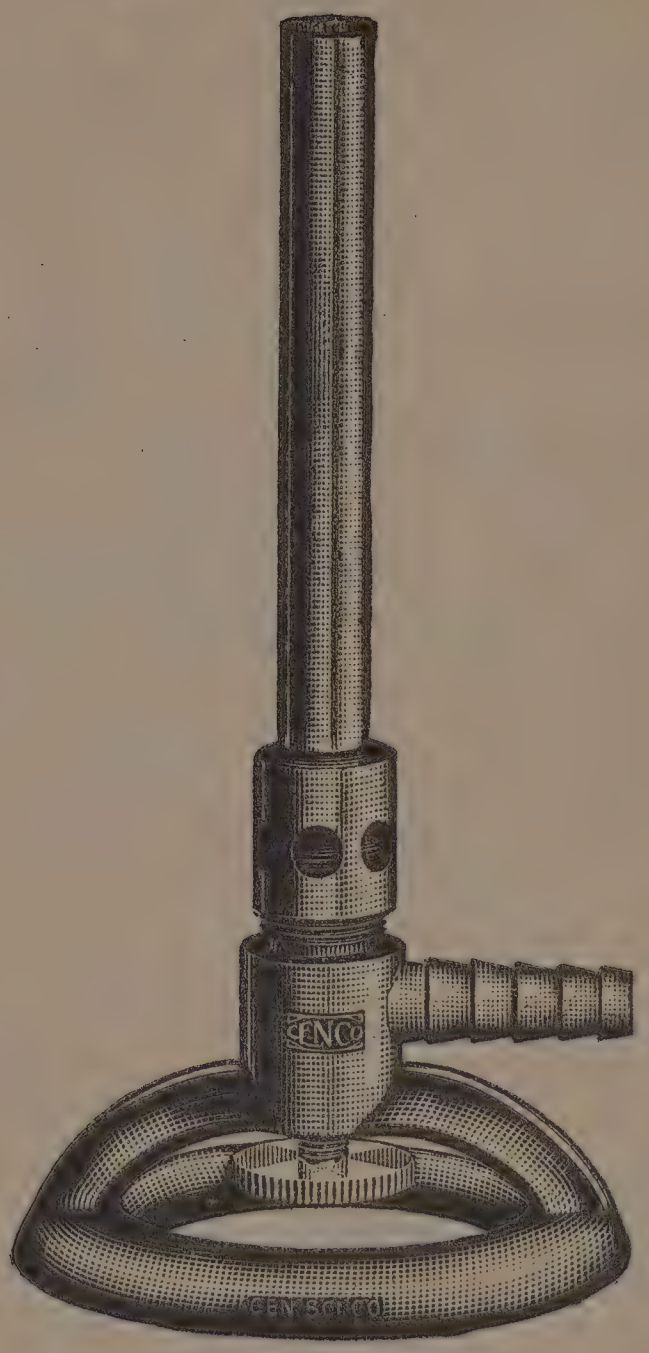

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March
1930
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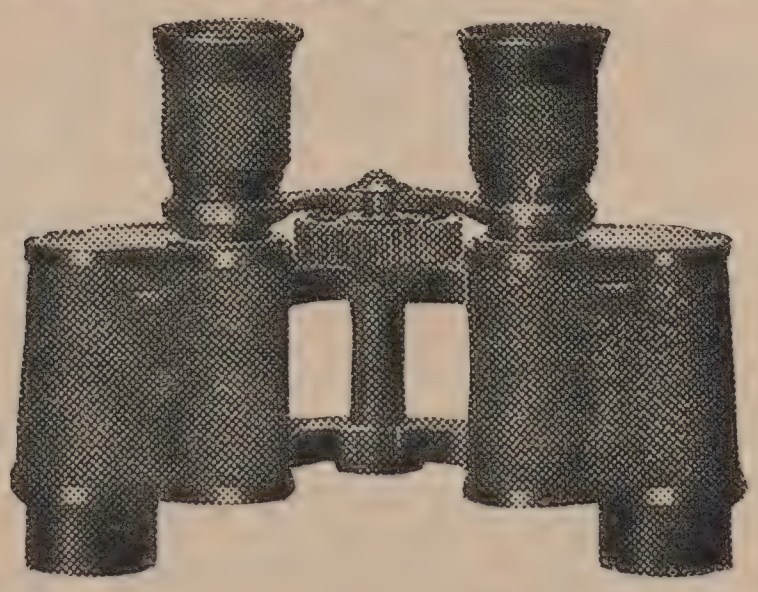

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NORTHWEST SCIENCE

VOL. IV MARCH, 1930 No. 1

The Association is not responsible, as a body, for the facts and opinions advanced in the papers published by it.

EDITORIAL

The Fifth Estate

WHEN Franklin was in England the British Parliament was assumed to be composed or representatives of three estates: the lords spiritual, the lords temporal, and the commons. Edmund Burke, pointing to the reporter's gallery, said "There sits a *Fourth Estate,* more important far than they all." Thus was the all-pervading power of the press recognized and dignified by a new term.

A new power has been rising in the land and is making itself felt in every quarter. Its influence in the newer portions of our nation, such as the Pacific Northwest, is as strong if not stronger than in the region where Franklin first applied scientific methods to the investigation of lightning charges. This power is termed the *Fifth Estate by* Arthur D. Little, who says, "This *Fifth Estate* is composed of those having the simplicity to wonder, the ability to question, the power to generalize, the capacity to apply. It is, in short, the company of thinkers, workers, expounders, and practitioners upon which the world is absolutely dependent for the preservation and advancement of that organized knowledge which we call Science. It is they who bring the power and the fruits of knowledge to the multitude who are content to go through life without thinking and without questioning.

We have, in the Northwest Scientific Association, a *Fifth Estate* worthy of the name, and fully capable of molding scientific thought, advancing organized knowledge and encouraging investigative work in the Northwest. The organization is long out of its swaddling clothes. Its rapidly increasing membership, its enthusiastic meetings and the stimulative examples its members set for the neophytes in science all point to its maturity. Let us, therefore, make it a power for good, let us use our vision, our trained intelligence and our open mindedness to the best advantage by bringing the fruits of our knowledge to the multitude, and so prove our membership in the *Fifth Estate.*

"As lantern bearers, it is the clear duty of the Fifth Estate to show the way."

With this issue of *Northwest Science* are presented some of the changes in the journal authorized by the Editorial Board. Consistent with the growing power of the Association we wish to make our publication as outstanding as our funds permit, striving ever for a pleasing as well as an accurate and economic presentation of the Association's writings. Suggestions for improvements are solicited.

The Present Status of Scientific Education and How It Came to Pass[1]

By E. A. Bryan
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THE supremacy of science and the scientific method, as an instrument of higher education today would be readily admitted. It was not so a half century ago. The young David, Science, armed only with sling and shepherd's purse and pebbles from the brook was in a gigantic conflict with the Verbalistic system. Only a little while before, there had been no conflict. Verbalistics held undisputed sway in the realm of higher education, disturbed slightly from time to time by the titilation of a safe and sane discussion of the speculations of the philosophers.

Of course, as I have used the term "Science" it is applicable to the study of the social as well as the physical phenomena. The method of investigation, of the weighing of evidence, classification, the perception of and statement of the underlying rule or principle is the same, whether in the study of men or things. The laboratory method as contrasted with the learning, and reciting, the dicta of the authorities now prevails throughout almost the entire realm of higher education.

Prior to our great Civil War higher education in America was still in the medieval stage. The Novum Organum had not as yet really become the new instrument of the University. It had not as yet penetrated through the coat of mail of clasicists and entered into the consciousness of University faculties. The forces which we were to lead to its entrance were to come from below, not from above. The dictum "Education is from above downward" was not true in this instance. The "Revival of Learning" was a better phrase, with which to describe the results of the movement which had begun some four centuries earlier, than was the word "Renaissance" or new birth, for "Learning" not "Life" had come to be the "be all and end all" of university activity.

A knowledge of Latin paradigms, and Latin grammar and idioms, and versification, and the Latin vocabulary, with the translation of a few Latin texts absorbed largely the energies of the college student. The mechanics of the Greek language with the meagre knowledge of its great texts absorbed the rest. Mathematics formed the other leg of the tripod, but it was a short leg at best. The process of a university and of the lower schools was verbalistic; the end arrived at was "Learning." "Learning" was largely a knowledge of words, forms and formula—the result of verbalistic gymnastics. Learning was a content to be acquired and possessed. Its counter part could be found in grammars, dictionaries, and texts—dried and preserved. Well might medieval learning be described as voluminous. The "Learning" of the century prior to our Civil War might well be compared to the scholarship of the Chinese in the five classics of the "Confucian" texts. It was not so of the earlier period of the Renaissance. Then the Latin and Greek languages had been a vital means to more vital ends. Theology, Philosophy, Politics, and Economics (which had a great existence long before Adam Smith) could be approached only through these lan-

1 Address of retiring President, Sixth Annual Meeting, Dec. 27,-28, 1929.

guages. There was no other adequate means of giving or getting than through these languages. As early as the advent of the Industrial Revolution this was no longer so. As the new life of the world expanded in geograhical knowledge, in commerce, in productivity through mechanical progress the university became more remote from life's activities and its processes and aims became less and less defensible. Mere "Learning" was no longer enough. Its contents must be a vitalized content closely related to the human being. Learning tended to become pedantry. Its happy possessor prided himself on quotations from his vast storehouse of "Learning" which few could understand. He would roll the rhythmic cadences of the classic poets under his tongue as a sweet morsel. He enjoyed the isolation and the hero-worship which this brought to him as a scholar.

When the push of new and vital knowledge began to disturb his self-satisfaction the scholar whose possession was exclusively this remnant of medieval learning rose to its defense by an attack on what he called "the bread and butter philosophy." An American scholar once boldly voiced his sentiments of his colleagues when he declared that "a university is a place where nothing useful is taught." And he was cheered to the echo by the "scholars of the day." And he meant precisely what he said, and they understood and approved. He meant that any material or useful thing disturbs and diverts the soul from its legitimate growth; that only those things which are remote from the daily life of man may be proper instruments of the growth of his mind.

This harmonized well with the psychology of the day, which was the study of metaphysics as distinguished from physics. All physical explanation of human phenomena was decried. The soul of man was conceived of as a distinct non-material entity, that could be known, analyzed and understood wholly apart from its physical habitation. One philosopher of that day represented it as a being sitting within its "earthly house of this tabernacle" looking out upon this mundane sphere through windows of which there were five. These he called "the windows" of the soul, that is to say the five senses.

This spiritual entity conceived of as so separate, so distinct, could, of course, feed upon and be nourished only by spiritual food. Hence the danger of the use of any material thing or any physical phenomena. *Ideas* came nearest to spiritual food and as *words* are the representatives of ideas verbalistic means and methods are the only proper agency to be used in the education of the soul. A vast accumulation of ideas embodied in words, principles, rules and dogmas constituted *"learning."* This vast storehouse one might get and hold if "one small head could carry all he knew." The possessor of such learning was henceforth an "Authority" whose dicta others should learn and possess.

Out of this status (and well we may describe this as a status) sprung the doctrines of "discipline" and "culture." The getting of this content was "discipline;" and the verbalistic regime, the only proper means of getting it. The end was "culture," your sure possession when you once got the content. It should be observed that this theory of discipline came quite late, and that there are remnants of it still lying about loose in many so-called "institutions of learning." From its initial statement it developed into an assumption that the particular subjects and the particular methods of the medieval curriculum were the only means of discipline and culture possible in a university.

This absurd assumption and the philosophy by which an indefensible curriculum was maintained and defended in the American university reached a climax soon after the Civil War. A body blow was dealt to it during the Civil War from which it was never able to recover. Under that philosophy a faculty of six men—or at most seven—could (and did according to the accepted standards of that day) maintain a very respectable college. Such a college usually had a president, who taught mental and moral philosophy and the evidence of Christianity; a professor of Latin; a professor of Greek; a professor of mathematics and astronomy (the only science which had etheral contacts); a professor of Natural Philosophy (who taught a part of what the book had to say about mechanics, chemistry, botany, etc.,); a professor of Belles Letres, and public speaking; and rather rarely to these six, was added a professor of modern foreign languages whose students were treated not as a class on equal terms with other students but as a class to themselves. To these were frequently added sundry instructors and tutors for the preparatory subjects.

The curriculum followed was the "narrow" curriculum for which definite and strict preparation on a curriculum just as narrow must be made and in which an undeviating course must be followed. The prescribed studies must be *learned* for admission, and the prescribed studies *learned* for advancement to graduation, and the graduate had become a learned man. And man it was exclusively to about that period, for woman was not as yet eligible to college degrees.

But beneath the lid which was held down tightly by conservative faculties the pot had begun to boil. It had almost boiled over at the end of the first quarter of the nineteenth century, but the lid was clamped down more tightly than ever and steam did not escape much until after the close of the Civil War period and then it burst forth with a mighty energy.

The quarter of a century which followed the War has been well described as the "Patch-work Era" of the American college. The curriculum was indeed a patch-work throughout this period. The accepted philosophy was being attacked front and rear. It was alleged that it produced neither discipline nor culture and it was asserted that it was obsolete and that the so-called "learning" was useless when it came. New subjects were crowding in for recognition. The great modern languages were demanding an equal place with the great classics—English, German, French for equal recognition with Greek and Latin. History refused to be further ignored as a college subject, or to be known only through historical Latin and Greek texts. The application of mechanics and physics would no longer be denied a place. Economics (largely the texts of the classic economics) must have a place. The physical and biological sciences as a study of the new and living facts of the world about us, and not the memorizing of obsolete and unverified assertions of so-called authorities were clamoring aloud for recognition. The "defenders of the faith" were yielding slowly and as against odds to the inevitable. A patch-work was the result. Someone of the day truly says, "Each faculty member claims what he wants and receives what he can get." The curriculum was "the result of many forces in unstable equilibrium, the result of expediency and the exigency of compromise." Two things helped to clarify this situation and bring order out of what for a time promised to be revolution in higher education." The first of these was a migration of many

of our young men, restless under the restraints and deadness of the old regime, eager for the new world of the physical sciences, to Germany—especially was this true in chemistry. To the men of this day it is inconceivable that the so-called instruction in chemistry which the college offered should have been tolerated. The study of chemistry was wholly a matter of nomenclature and classifications and alleged reactions given out by textbooks or by lectures, learned by rote by the students, recited back and labelled as chemistry. No real laboratory or laboratory work. A few startling illustrations of reactions, (if the experiment did not miss fire) as it frequently did. Physics, which if taught at all, was better taught, nevertheless was largely in a purely informational stage. Its content was added to the growing mass of "learning." Botany and zoology were matters of learning names and classifications. The whole business was one of information-giving and information-getting. Whether the information was true or false was a secondary and unimportant matter. In this juncture Germany in its use of the laboratory system and its doctrine of thoroughness in first-hand investigation rendered us a great service. As for history and political economy and the other social science subjects they were as yet, insofar as they forced their way into the curriculum in the "gall of bitterness and the bonds of iniquity." Even John Stuart Mill is said to have declared "The Science of the Political Economy is now complete. There is nothing further to be added."

The other thing which brought life to light was the advent of the elective system. This was the declaration of American educational independence. What if it did usher in the patch-work era! Better was the piebald patch-work era, with freedom and life, than the deadness of an outgrown system. It meant freedom in the choice of the subjects of study; freedom from the shackles of a dead system; freedom to approach the only source of truth, reality itself; freedom to express the truth as you find it, not to repeat what someone else had said about it; freedom to challenge all the authorities the world had to offer; and freedom for you to speak with the only real authority.

The names that stand out as academic standard bearers of this revolution in college education are Charles W. Eliot, President of Harvard, who brought in the elective system, and Andrew B. White, first president of the new Cornell, who added to freedom of election a broader menu with the German conception of thorough and exhaustive study of some one realm of human knowledge.

I hold in my hand a catalog of Harvard for 1871-2, two years after Eliot became its president. With the wisdom and restraint not characteristic of youth, the mastermind of Eliot, age 35, was definitely proceeding from what had been consecrated by usage and argument to what ought to be, and was leading the way out of the slough of dispondency into which the American college had sunk into the promised land of freedom and light. It was the beginning of the transition from verbalism and authority to freedom and truth. It was the fulfilment of the prophecy "Ye shall know the truth and the truth shall make you free."

I should like to comment on this exhibit as an illustration of an American university at its best and greatest in 1871, but 50 years ago. And beside it I place by way of physical contrast a catalog of one of our colleges of today. As you readily see (holding up a 1929 catalog) this belongs in a class with other over-stuffed furniture of

the present period. I wish I might compare the spiritual freedom of this with the bonds that still clung to the very best of these, but I cannot.

It was physical science and the laboratory method that led the way. We knew little of the material world about us, and we wanted to know much. Unshackled by a moribund system we could approach nature directly. She would reveal to us the very truth. Her material things, inorganic or organic, we could touch, taste, smell, handle, weigh, measure, analyze, synthesize, compare, and we could recall and organize the results and get a bird's-eye view of the whole. We called the new chemistry of the day "analytical." We built laboratories bought or made apparatus with which to work, and turned the students loose in it without lockstep and invited them to look and smell and taste and weigh and know. The curriculum might be chaotic, but forces were at work which would bring order out of chaos. Out of doors trooped the biologists. The fowls of the air and the fish of the sea were now their sacred subjects. Resist it as they might, the doctrinaires of the old school could see the virus spreading. One college president, still panting from the conflict, boasted that he had been able to hold four-fifths of his students, in the classical course, and that only one-fifth of his students and they the poorest, were enrolled in the scientific course. But when you looked into what he called his "scientific" course you found that poor remnant drinking of the very drugs of what had been misnamed science.

One of the most powerful factors in bringing to pass the shift from verbalism to science and the scientific method, if not its most powerful factor, was the advent of the "Land Grant College System." It is not my purpose here to discuss this, much as I should like to do so, but I should be recreant to my duty, if I failed to call your attention to it in this connection. The Morrill Act of 1862—great peace act in the midst of war—brought to bear on the educational revolution the consideration of the *useful* and the *practical* as well as the *true* in the means and ends of higher eduction. The old regime had pushed its doctrine of soul development on non-material food to its extreme in its declaration that "the university is a place where nothing useful is taught." The aspiration of the multitude for knowledge and the consequent power had reached the point where it was determined that no longer should those who sat in the darkness of industrial occupations be denied admission to the light of knowledge. So the Morrill Act of 1862 was the declaration of freedom and independence to the industrial classes.

No act or educational movement was more misunderstood or misrepresented. It set over the industrial classes and their needs as against the professional classes and their prerogatives. The instrument in accomplishing the end in view must be primarily the natural and physical sciences pursued in the only possible rational way, to wit, by the laboratory method. I am here to say that in comparison with all other forces making for the revolution in higher education and the triumph of science as basic therein, the Land Grant college movement has been incomparably the greatest. But this thesis I must not now discuss.

Having spread from one to another of the subjects which are basic in the college curriculum, and having been enriched by the free admission of the great modern languages, the scientific method of approach invaded the social sciences last of all and finally made the triumph of this method complete.

That did not mean, nor should it

have meant, the exclusion of language as a basic subject in the college curriculum. Language must forever be a vital element in human education, elementary and higher. But the revolution meant in the first place the admission of the great modern languages and the modern content of each to an equal place in the educational process. Even in the case of our own rich literature, whatever the college student got he gathered through sources outside the college classroom. Second, he was free to choose among the sciences and was afforded facilities for their pursuit. Third, the Science of Man, as revealed in history, politics, economics, sociology, ethnology, and the like, was admitted freely and on equal grounds to the college curriculum, and slowly but in due course of time, the scientific method became the basis of this science also. The spirit of research followed in every field of human knowledge. Facilities for the pursuit of the new knowledge necessarily followed close after the new endeavor. Laboratories multiplied. Much old so-called "illustrative apparatus" went into the junk pile. Instruments of precision and standardized reagents were necessary. Wherever these were lacking they were created. New buildings adapted to the several purposes multiplied. Libraries and library facilities were fitted to present needs. Eagerly the youth siezed the new opportunities. College Halls were crowded to bursting. Subjects of the old curriculum that seeemed all embracing were split into related groups. Botany became ecology, plant physiology, plant pathology and what not. Wholly new sciences came into the field of vision, e. g., bacteriology. The public reacted to the new knowledge and the new skills. Medicine and surgery were revolutionized. Not only did knowledge (as contrasted with learning) become respectable but even useful knowledge could hold up its head in academic circles. The applications of physics, mechanics, and the mathematics to the arts and even the mechanical and manual instrumentalities by which these were made were admitted to the academic circle, and shops as well as museums became a part of college facilities, and, "tell it not in Goth", even agriculture and the arts connected with domestic life found a place in the charmed circle called academic. Even in these there were found to be an abundant volume of fact, which the human mind could come to know. And beneath these facts there appeared to be law—immutable law—which might be known and used in the cause of human betterment. Moreover, when organized and stated they seemed to assume the dignity of a Science and might even be a proper instrument of human discipline and human culture.

And so it has come to pass slowly and by degrees that we can see what we see. "Learning" in itself is a lonesome figure. Learning as an end in itself, learning as a content, to have and to hold as a content in your alleged mind, has vanished. For why? No sooner is it formulated, no sooner is it put into dogmatic form which may be learned, than it is challenged, then it ceases to be "an accepted truth."

A *"scientific fact"* today must always be prefaced by the declaration "so far as we now know" this is true. The body of science is a living, moving body. Every stage of its academic use is an instrumental stage. We learn the multiplication table and the addition table merely that we may use them in higher combinations. They are not ends in themselves Chemistry is not an end in itself. We do not acquire it to parade it but to use it to ulterior ends. And so with each and

(Continued on page twenty-one)

Leadership Qualities of Superintendents of Schools[1]

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UNIVERSITIES and Colleges that train individuals for public education positions are concerned with training leaders for special positions, one of which is the public school administrator. The type of individual who succeeds best in such a position is a matter of deep concern. It appears that the best way to determine the nature of such a personality is to analyze the job or to analyze the abilities of those who have succeeded best as executives. A number of attacks have been made on the problem. In many cases, however, the qualities enumerated and the abilities stated are the results of personal opinion based upon one individual's contacts or experience.

The qualities of leadership in school executives, or any other type of personality for that mateer, are difficult to identify. To determine the knowledge required for the duties of the office is difficult enough, but to define the more intangible qualities such as faith in education, morale, or initiative is exceedingly more difficult. It is quite pertinent, however, to ask what are the most important leadership qualities that a superintendent of schools should possess?

Because there is difference of opinion on these matters, the writer, together with Dr. L. O. Cummings, Professor of Educational Administration, Harvard University, undertook to get a statement of a composite judgment of a number of school executives. The results should be of more value than a guess and even better than any opinion based upon general impressions rather than facts.

The first task was to get a list of assumed qualities of educational leadership. This was found in a rather comprehensive list which appeared in a study made for a master's thesis at Harvard University in 1925. In that study, Mr. H. C. Ramsower of Ohio had spent the better part of a year in determining the leadership qualities of county extension agents.[2]

He had surveyed the state leaders of county agents to secure the qualities which they found to be outstanding in their most successful county agents. The following twenty qualities are the result: broad knowledge and interests, technical knowledge, commanding presence, faith, enthusiasm, courage, vision, ability to plan and organize, power of expression, resourcefulness, judgment, initiative, integrity, tact, perseverance, friendliness, tolerance, unselfishness, sympathy, cooperation.

Those twenty qualities were taken as a point of departure for studying the nature of successful superintendents of schools in municipalities. A form was made, upon which were listed the twenty qualities with their definitions and where there were provisions for ratings of A, B, C, and D on each quality. Each form was so constructed that two superintendents could be rated.

These forms were presented to twelve city superintendents who were in attendance at Harvard University in the summer of 1927. These individuals were given directions to recall to mind the two most successful superintendents with whom they had been acquainted and to rate each of them on the twenty qualities by checking in the A, B, C, or D column. They

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1 Presented at the Sixth Annual Meeting, Northwest Scientific Association, Dec. 27, 1929.

2. Ramsower, H. C., M. Ed. Thesis, Harvard University, 1925.

were advised to take special care in the work as follows:

"One of the problems in making such a rating is the tendency to rate each quality on the basis of one's general estimate of the man rated. Take particular care to consider each quality independently and decide to what degree the man you are rating possesses it. You may he helped in this by thinking of an actual instance in the man's career. In the absence of a concrete illustration on which to base your judgment be careful that you do not fall back on your general estimate or give a B rating instead of an A merely by reason of the lack of a concrete case."

Full returns were secured which gave ratings on twenty-four superintendents. The twenty-four ratings were then tabulated. Those qualities were then selected in which the A rating equalled or excelled the B, C, and D ratings combined. There were ten such qualities which will be listed later. We then defined carefully each of the ten qualities so that we could have as complete an agreement and understanding as possible.

The ten qualities with their definitions were placed on a rating form as before and presented to the same superintendents with the same directions as in the first case.

Considerable time was taken in explaining the definitions of terms and soliciting careful work. The results were tabulated and graphed. In this case nine complete reports were obtained. The diagram, Figure 1, shows the results listed in the order of the A ratings. Eighteen superintendents have been rated on each quality.

Figure 1

CONCLUSIONS

1. The leadership qualities thus obtained appeared in the following sequence: perseverance, ability to plan, integrity, courage, faith, technical knowledge, judgment, initiative, cooperation, vision.

2. The ten qualities, without exception, appear to be important in educational leadership. This is evidenced by the fact that successful superintendents rate A and B on the qualities, that in all cases the A and B ratings exceed the C and D ratings, and that in the cases of the first eight the A ratings exceed the B, C, and D ratings combined. They appear, also, to agree with common sense.

3. The results are considerably better than a guess and more reliable than unsupported opinion.

Fire As a Factor In the Management of North Idaho National Forests[1]

By Howard R. Flint
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FIRE has occupied a place unique in the development of the forest growth which now covers the 6,297,000 acres comprised in the National Forests of northern Idaho. There seems to be no good reason to doubt that fire has played a leading role in these forests for centuries past and that it may continue to be an important factor in the management of them during the near future. Since it is of an elemental nature and has been, like the forest growth itself, a resultant or expression of several dominant climatic factors with which it has operated to determine, temporarily at least, distribution of species, composition of stands, age classes and plant successions in the forest, it may be regarded as having almost an equal status with precipitation, temperature or sunshine in its influence on the stands of the present day

During the past 20 years, 1910 to 1929, inclusive, a record sufficiently dependable for practical purposes has been kept of the cause of some 11,050 fires that have occurred in these National Forests. Of these fires of record, on which some sort of control action has been taken by the Forest Service, 7584, about 69% have been caused by lightning. These are the kind of fires for the origin of which no human agency is responsible and which may be expected to have occurred in approximately equal numbers during the long past and to continue to occur in about similar numbers in the near future. Unfortuately, there is no record available which, for the 20-year period, shows just how much area was burned over by the lightning fires, but it is known to have been great. Clearwater Forest may well be used as an individual example in this discussion because there has been less human interference and a smaller number and percentage of man-caused fires on it than on any other unit of the area under consideration. Per unit of area it shows a somewhat higher incidence of lightning fires than the average for northern Idaho. On Clearwater Forest, an uninhabited area of about 800,000 acres, during that time there have been 1622 fires of which 1516 or over 93% were caused by lightning. Only two of the man-caused fires are known to have covered any considerable area and the loss by lightning fires has been at least proportional to the number of fires due to that cause. The total area burned in the Clearwater Forest during the 20-year period is 554,440 acres. About 310,000 acres, or 57% of that area burned in one season, 1910. Granting that the burned area due to lightning is about in proportion to the number of lightning-caused fires, then such fires have burned at least 500,000 acres in the Clearwater unit alone in 20 years. During that time the Forest Service has controlled 90% of all fires in the Clearwater at areas of less than 10 acres each and 69% of them at one-fourth acre or less. Many of these fires would have become larger if left unattended and most of the large fires have been more or less confined in area by control efforts. At the rate of burning which has occurred, even under partial fire control, the equivalent of the entire area would have burned over in about 29 years and, in

1 Presented at the annual meeting of the Northwest Scientific Association, Forestry Section, at Spokane, Wash., Dec. 27, 1929.

a 100-year rotation, the growth of the area would have been entirely harvested three times by lightning fires alone.

Of course, no such thing actually happened in Clearwater Forest or in northern Idaho as a whole. It is apparent from the growth now found on the area that the distribution of fires has beeen irregular in time and in place. Some areas have burned over two or three times within a very short period, others have escaped entirely for 200 years or more. Of course, a reburn after 5 years or 10 years means but little loss of wood, but the effect of it is serious because a tree must successfully pass through its youth before it can produce any commercial wood, and if an area burns every 20 or 30 years, it will produce no wood marketable under present day conditions. On those areas that have escaped for relatively long intervals we now have mature timber stands. Although large in the aggregate and of great importance economically, mature stands of merchantable timber occupy but a small percentage of the area of northern Idaho. The best available estimate, admittedly rough, indicates that about 35% of the area of these National Forests is under timber of merchantable sizes and age classes. Some experienced foresters familiar with the situation believe this figure to be too optimistic.

In the northern Idaho National Forests as a whole the area covered by fire in 20 years has amounted to about 3,103,800 acres, or 47% of the total area. At this rate of burning the forests have been on about a 50-year fire rotation and the mature timber to be cut will be the result of fortunate accident; nevertheless, the situation is not quite so hopeless as it may appear. The following brief tabulation is indicative of the possibilities and the progress of fire control in the region:

	Clearwater National Forest			Northern Idaho National Forests		
	Number of Fires	Acres Burned	% Burned	Number of Fires	Acres Burned	% Burned
1910-19	489	505,150	63	3973	2,594,800	41
1920-29	1133	49,290	6	7077	509,000	8
	1622	554,400	69	11,050	3,103,800	49

From this brief consideration of fire statistics, it is apparent that lightning fires alone must have played a very large part in the life history of the vegetation of the region. To the influence of these fires must be added that of an unknown number of fires caused by Indians before the white man's day and a great many fires caused by white men during the industrial development of the country to its present stage. Since, in the conversion of a natural forest into a managed forest, the administrator is under the necessity of starting his management of the unit with species, growing stock, distribution of age classes and soil conditions as he finds them, the past influence of fire on any present scheme or system of management is clearly apparent and it becomes desirable to inquire into the effect that fire has on the stands.

Due chiefly, perhaps, to the large quantity of fuel usually present on the ground, to the susceptibility of conifers to fire injury, and to the condition of more or less extreme drought which makes is possible for them to become large; most of the larger forest fires

of northern Idaho kill a large percentage, very often 100 per cent, of the trees over the areas which they cover. In only rarely exceptional cases does a single fire in living timber more than 20 years of age consume the trunks or the larger branches of the green trees, these parts remain to become dry fuel for any future fire that may occur on the same area None of the conifers of this region sprout from the roots, therefore, when the aerial parts of the tree are killed by fire, reproduction must come from seed only. Many of the shrubs and herbs that grow under the conifers sprout freely from the roots and from a few to a great many of them, depending largely on the severity of the fire, spring into growth promptly, sometimes during the same season, after the fire has passed.

Insofar as the conifers are concerned, each of these large burns constitutes a bare area which can be restocked only by seeds which must come from one or more of three sources, viz:

1. Viable seed left in the duff layer or the soil after the fire.
2. Viable seed of the current or previous seasons left in cones on the fire-killed trees.
3. Invading seed from trees outside the area.

It has been fairly well established by observation and study that all three of the above sources of seed play parts of varying importance in the restocking of burned areas. A survey of burned areas completed on the Clearwater Forest in 1924 indicates that, on that Forest, at that time, at least 65 per cent of the total burned area had restocked naturally to the extent of 100 seedlings or more per acre of various coniferous species and that restocking is a continuing process with density of the new stands slowly but generally increasing. A density of 100 seedlings per acre is not commonly regarded as a satisfactorily stocked stand in this region. For convenience in field practice that degree of density was arbitrarily chosen as the minimum which marked the line between areas restocking and those not restocking. Areas described as of minimum restocking bore from 100 to 500 seedlings per acre.

In a region of mesophytic forest, such as this, the species which make up the true climax type are those which can continuously reproduce and grow under the shade of the parent trees. When species which can meet this test have taken full possession of an area a state of approximate equilibrium will persist until some accident modifies the habitat. The factors most commonly concerned with such changes in this region are fire, insect epidemics, diseases and lumbering operations, or a combination of two or more of these.

During the recent past, fire has most often been the agent which brought about profound and widespread changes. Some of its most apparent effects are:

Change of surface soil from acid to alkaline.

Greatly increased light intensity at the ground.

Widened range of temperature.

Increased rate of evaporation.

The more or less complete elimination of life, including many soil organisms from the habitat.

None of the other factors involved has been sufficiently potent and severe to bring about such radical changes over large areas of forest. Insects usually confine their attacks to one or two species of trees in a stand at any given time, and to a rather narrow range of age classes. Their action is far less sudden and complete than that of fire. Their influence on the soil is indirect only. The action of disease is quite similar in effect to that of insects. Lumbering operations are, in theory at least, entirely within hu-

man control and are confined to the very recent past.

Development of a forest to the climax stage or climax formation is a more or less orderly process effected by the succession of several plant associations. Areas in this region denuded by fire are but rarely if ever reduced to the status of primary bare areas which are completely sterile as to soil and germules. Usually the succession on a burned area starts, not with lichens and mosses, but with higher plants, often, as suggested above, with coniferous tree species. Since some tree species, lodgepole pine, for example, and to a less degree, perhaps, western white pine, invade burned areas and survive on them more readily than others, the composition of stands of timber in this region are in a very large measure the result of the effects of fire. The forester may or may not desire to produce and reproduce the climax type of the site he manages. The species of wood produced by some one of the intermediate stages of succession may more adequately meet his needs. If he cannot bring about the silvicultural conditions he desires by the less drastic method of cutting he may, in exceptional cases, resort to controlled use of fire to create a secondary bare area on which he can build more in accordance with his desire. In any case his major purpose will probably continue to be the productior of a large volume of wood of commercial size.

With the foregoing statement of statistics and conditions in mind, it is apparent that if the forester desires systematically to harvest full crops of commercially mature timber, his first consideration in this region should be in the effective control of forest fires. Their effects, from either the botanical or the economic points of view, are so profound and general that there can be but little technical forest management until the firecontrol problem has been mastered. Man must substitute his methods of removal of stands for the almost complete but more or less irregular removal of woody growth that fire has brought about in the past.

It will be ineffective to plant bare areas, cut to reproduce desirable species, plan for sustained yield, or to keep young growth free from disease or insect attacks unless the resulting stand can be protected from fire throughout the rotation. From an economic point of view, the relative cost of fire control on lands in this region as compared to that in other timber-producing regions will go far toward determining whether or not the management of this or that character of land can be a financially successful enterprise.

That effective forest fire control is within the realm of the possible is indicated by the comparison, given above, of fire statistics of the last two decades. During the second period the area burned over, with increased protection, has been but a small fraction of that burned during the first of the two periods. Forest protection organizations on these National Forests, still woefully inadequate to meet the extreme season, have been gradually built up since 1907 and progress still continues. At the opening of the 1929 season no administrator of any of the National Forest units under discussion believed his unit adequately protected. It seeems probable that adequate protection can be provided when forest owners, in the case under discussion, the public, is willing to pay the price.

Chemical Characteristics and Utilization of Some Peat Soils In Northwestern United States (Abstract)

By W. L. Powers
Oregon State College

FOUR different types of peaty soils have been recognized in the Northwest. A profile sample of the soils studied are:

1. Tule and sedge peat from Klamath marshes located in an elevated semi-arid region and having slightly alkaline reaction. The substratum to ten feet down is collodial, diatomaecious, siliceous muck.

2. Woody-sedge peat (a) from Lake Labish and (b) from Wapato Lake in the subhumid Willamette Valley, with a marshy substratum and faintly acid reaction in the upper horizons. (c) Soil from Coquille Valley and (d) from Sandpoint, Idaho, were examined and correlated with this group.

3. Sedgy, acid, muck from near Clatskanie in the lower Columbia river bottom.

4 The fourth kind of peat is brown, acid soil from the coast near Astoria, formed from sphagnum moss and woody matter including slowly decaying spruce wood. The substatum is silty clay loam. A profi'e sample of raw sphagnum peat from Cottage Lake near Seattle has been analized and grouped with this kind of peat.

Earlier fusion and strong acid analyses show these soils are usually high in nitrogen and sulphur and low in potash.

Nearly all these soils contain contributions of mineral material. Volatile matter in the surface layers is found to be fifty to ninety per cent. Reaction values were determined by the use of 1:5 suspensions using the hydrogen electrode.

The net amount of bases, (Ca and Mg) extractable with tenth normal barium chloride is low except with a subsoil overlying the calcareous or marly substratum. The amount of bases so extracted seem to decrease as organic content increases, indicating that material so held in nearly pure peat is very limited and the degree of saturation with bases low. Little data from other investigations are to be found for comparison in this regard.

Water soluble nutrients were determined using five parts of water to one of air dry soil (Seattle soil 10:1) and reported in per cent dry weight. Analyses were made of samples representing each group from fallow pots treated as were triplicate parallel series of two gallon pots employed in planthouse fertilizer trials. Nine to twelve treatments were used, making three to four dozen pots of each kind of peat.

Water soluble potassium in untreated soils from these areas is limited, especially in case of Klamath and of sphagnum peat. All three soils show an increase in water soluble potassium six weeeks after treatments with potassic salts, barnyard manure, or calcium carbonate, or a combination containing one or more of these. Analyses repeated after six months using Lake Labish soils showed a general increase in water soluble constituents from incubation in the planthouse in an uncropped condition.

Oats, mint, potatoes, flax and clover have been grown in fertilizer trials with the four kinds of peat two gallon pots and or on field fertilizer plots. Potassic salts and other treatments mentioned which have increased water soluble potassium generally result in in-

creased yields. Full efficiency of potassic salts was not obtained except in the presence of a fair supply of nitrate.

Trials indicate that potassium sulfate will give slightly larger yields and a higher quality of product than potassium chloride.

The length, strength and yield of flax fibre has been markedly increased through the use of potassic fertilizers using Lake Labish soil. In one case the fibre yield was trebbled. Cooking quality and dry matter content was highest with potatoes grown with the aid of potassium sulfate and a large number of pressure tests with automatically registering equipment clearly indicates the potatoes from this lot were slightly firmer as judged by two seasons results.

The study is being continued and effect of imperfect drainage, liming and soil inoculation are projected, in which the Department of Bacteriology is cooperating in measurements of carbon dioxide evolved and in studying the microorganic activity as effecting the soil solutions of these peat soils.

Drainage and usually supplemental irrigation are desirable for moisture control in these soils.

The marly substratum and well decomposed condition of Lake Labish peat and the mineral fraction explain in part its established productiveness, while the low concentration of potassium indicates increased use of the same. The raw brown woody acid peat is suited for production of grasses and cranberries and with lime, manure and potassic fertilizer may be used for truck crops.

Klamath marshes with deep drainage and supplemental irrigation are mainly suitable for forage crops. In time such hardy vegetables as the climate will permit and the market require, may be grown thereon.

Earthworms longer than a man and an inch in diameter are reported in *Nature* as the quarry of a naturalist's hunt in southeastern Australia. Average specimens range from four to six feet in length, and one nine feet long was observed by Charles Barrett, member of the expedition. An extreme length of eleven feet was reported though not seen on this expedition The worms make loud gurgling noises when they retire into their burrows on the approach of a possible enemy. Their greenish-translucent eggs have tough, horny shells, and are from two to three inches in length.

Tularemia, newly discovered disease of rabbits, rodents and men, may also affect cats, muskrats, pigeons, ring-necked pheasants, grouse and quail, it appears from studies reported to the American Public Health Association by Dr. R. G. Green and E. M. Wade, of the University of Minnesota and the State Department of Health. This new disease which has caused much concern in public health circles, is acquired by men who handle infected animals. The fact that many more kinds of animals may have the disease greatly increases the danger to human beings by increasing the possible sources of infection.

Rustproof steel is easily welded by the acetylene-oxygen process and is even more rustproof after welding than before due to loss of carbon, silicon and manganese during melting. These findings by W. Hoffman, German metallurgist, have just been announced by the National Advisory Committee for Aeronautics at Washington. The physical characteristics of rustproof-steel welds are better than those of soft-steel welds but the hardness of the metal due to welding must be removed by heat treatment. The rustproof steels most used contain large percentages of chromium or chromium and nickel.

Notes on the Contractile Roots of Brodiaea Lactea (Lindl.) Wats[1]

By Frank H. Smith
Department of Botany, State College of Washington

PLANTS that reproduce by means of subterranean organs are usually characterized by a definite depth position at maturity. This depth is reached by a downward growth of the stem or by means of contractile roots. Contractile roots are found in both the monocotyledons and the dicotyledons but are much more common in the former group. This is because the prolonged life of the root cortex, due to lack of secondary thickening, allows for greater changes at maturity. One of these changes is the transverse wrinkling of the cortex accompanied by a distinct shortening of the root.

Rimbach was one of the first to study the structure of these contractile rots, considering species of *Allium, Arum, Lilium,* and others. He reached the conclusion that the shortening was due to an increase in the radial and tangential measurements and a decrease in length of the inner cortical cells.

M. B. Church, after her study of *Cooperia Drummondi* Herb., drew the following conclusions; (1) roots do shorten, (2) the parenchymatous tissue of the cortex is the seat of activity, (3) the cork and vascular tissues are passive, (4) the cork is ultimately crushed, (5) there is a region where wrinkling is evident and shortening can be measured, a region showing shortening but no visible wrinkling, and an unchanged region, (6) in dicots the vascular trace becomes visibly curved inward and outward in a wavy fashion while in monocots the vascular bundles remain practically straight.

Agnes Arber, in her study of *Hypoxis setosa* Baker, concluded that the transverse wrinkling was limited to the cells of the outer cortex and that the inner cortical cells and the vascular cylinder were not effected.

The present investigation has shown that in *Brodiaea lactea* the cause of the contraction is not a change in the relative diameters of any of the cortical cells. Also that the last generalization given by Church will not apply in this case.

B. lactea produces corms varying in size up to two inches in diameter. These are covered with a tough fibrous sheath that is heavily lignified at maturity. A new corm is produced each spring by the terminal bud of the old one. This absorbs the reserve food material of the old corm and later the products of photosynthesis so that each corm is larger than the preceding one. At the time of flowering, late June or early July, the new corm has no fibrous roots but all moisture is absorbed by the roots of the old corm. As the latter finally disintegrates an abscission layer is formed, separating the two.

With the coming of the fall rains the new corm produces fibrous roots and the terminal bud that is to form the corm of the following vear starts its development. Also axillary buds produce offsets. These vary in number from one to ten though two or three are usually found. Before winter causes a cessation of growth these offsets have developed a small leaf and the rudiments of a root. In the spring this invariably develops into a contractile root. This type of root is never found on the corm itself.

These contractile roots are rather fleshy, one eighth to one quarter of an inch in diameter and two to five inches

1 Presented at the Meeting of the Northwest Scientific Association, Spokane, Washington, Dec. 27-28, 1929.

in length. At first they are smooth the entire length but soon, before growth has ceased at the tip, the upper portion becomes wrinkled. At the same time the root shortens and the small offset is drawn downward and away from the parent corm. Instances were noted where the cormlet had been moved more than three inches and the contractile root was still growing at the tip. If this process is repeated year after year it can readily be seen why old corms are found at a depth of one and one-half feet. Offsets are very rare on these deep-seated corms.

Upon sectioning and staining the roots is was found that the wrinkling and shortening is closely connected with layers of collapsed cortical cells. These layers, as they first appear, are fairly regular in their vertical distribution, being separated by four to twelve rows of normal cells. The horizontal distribution of these collapsed cells is very irregular. The possibilities of unequal srains being placed on the vascular stele can readily be appreciated. As the first layers of collapsed cells appear the vascular system is straight. More of the cortical cells collapse and the stele, which is very small in comparison with the diameter of the root, begins to assume a wavy appearance. The region of greatest distortion is toward the top of the root. Here the layers of collapsed cells are much thicker and are separated by only one or two rows of normal cortical cells. The stele is twisted and turned back upon itself many times, with small waves showing in the larger loops.

During the shortening of the root the epidermis becomes loosened from the cortex and the offset is either drawn down through the epidermis or the latter is found folded and packed beneath the cormlet. The exodermis becomes slightly suberized and functions as an epidermis.

One of the moulds (a Penicillium) has been found to kill cultures of some bacteria, notably pus-forming cocci and diphtheria bacilli. This interesting news comes from Dr. Alexander Fleming, of the laboratory of the inoculation department, St. Mary's Hospital, London. The mould is similar to the common fungus that sometimes spoils oranges and other fruits. Even when cultures are filtered, the resultant liquid which is called "penicillin" is effective. It can be kept for some time if it is neutralized, but, if not, it loses power after from 10 to 14 days at room temperature. It does not affect all bacteria; for instance, the typhoid group is resistant to its action; on the other hand, staphylococci, streptococci and diphtheria bacteria are killed rapidly. Penicillin is not toxic to animals even when given in large doses, and it is also non-irritant. It is therefore possible that it may turn out to be a useful antiseptic for combating infections caused by certain pathogenic bacteria.

A new petrified forest, the only one so far discovered with the trees lying as they fell millions of years ago. is reported by the U. S. Bureau of Reclamation. It was found by a road-building expedition on the Lower Yellowstone reclamation project, about three miles southwest of Savage, Montana. The petrified forest covers several acres. Some of the trees are ten feet in diameter and over 100 feet long. They all lie with their tops pointing in the same direction, indicating that they may have been blown down by a storm. The shape of the trunks suggests that they belonged to the same forests that supplied the materials for the nearby beds of coal.

How Dangerous Are Dry Lightning Storms?[1]

By H. T. GISBORNE
Northern Rocky Mountain Forest Experiment Station
Missoula, Montana

IN the northern Rocky Mountain region the statement is frequently heard—and read in the newspapers—that dry lightning storms are one of the prolific causes of forest fires. From the records of lightning storms made by the forest fire lookouts in this region during the five seasons, 1924 to 1928 inclusive, specific information is now available for the first time to throw a dependable light on this problem.

During this five-year period the Forest Service has obtained and tabulated 14,754 records of all types of lightning storms in the northern Rockies. These reports are from about 300 stations very well distributed throughout northern Idaho and western Montana, including the Lewis & Clark, Beaverhead, and Helena National Forests east of the Continental Divide. Due to the large number of stations and the period of time covered, the effects of personal idiosyncrasies in observation and recording probably have been reduced to a minimum. In these records a "dry storm" is considered as one for which it was recorded that no rainfall reached the ground under the storm cloud, either before, with or following the occurrence of the lightning.

Out of this total of 14,754 reports, 1,238, or 8.5% show that the storm was really dry. By seasons the average occurrence was as follows: 1924, 7.3%; 1925, 7.8%; 1926, 6.4%; 1927, 8.8%, and 1928, 9.6%. This indicates that during some seasons there may be roughly about ten dry storms out of 100, whereas, in others there may be about six out of one hundred.

The important feature, however, from the viewpoint of forest-fire control is not so much the question of the number of dry storms as it is the proclivity of such storms to start fires. There were 8,408 reports which were definite and complete on this aspect of the situation and this appears to be a decidedly dependable basis for conclusions.

Of these 8,408 reports, 825 or 9.8% state that the storms were absolutely dry. This is a slightly higher percentage than shown by the total mass of reports, yet the difference is not enough to indicate that this smaller sample fails to represent the whole. From the 825 reports on dry storms, it is found that approximately 68% did not start fires, while only 32% were dangerous. Hence it appears that of all types of storms, if about ten out of one hundred are dry, only three out of one hundred are dry *and* fire starters. This is probably a much lower percentage than the average interested person is likely to mention. It may be lower than the average well-informed forester has been apt to state—because in the past there has been no specific information on this subject.

Still another phase of this problem lies in the question: Is a dry storm more apt to cause fires than a wet storm? The obvious answer is, of course, an emphatic yes. But the reports do not immediately agree with this. Instead they show that while 34% of all wet storms are fire starters, only 32% of the dry storms resulted in fires. A negative difference of two per cent does not seem to lend much emphasis to what might be the com-

1 Presented at the Annual Meeting of the Northwest Scientific Association, Forestry Section, at Spokane, Wash., Dec. 27, 1929.

mon opinion, and it may be that common opinion is correct and that other factors cause this apparent discrepancy.

It can be shown very readily and very emphatically from data on the rainfall which usually accompanies lightning storms that heavy rainfall does, as a rule, decrease the number of resultant fires, while there is greater danger with light rainfall. The other factors that probably are of most importance in this case are: the difference between many lightning flashes and few, and the difference between most of the lightning being confined to the clouds and most of it striking from clouds to earth. Obviously, if there are many flashes and all of them stay in the clouds there will be no resultant forest fires regardless of the rainfall, whereas, there may be only a few flashes all striking the ground and causing several fires if there is only a light, or no rainfall.

It is a well-known fact in meteorology that large clouds in turbulent action produce more lightning than the smaller, thinner and less active clouds. The larger clouds also generally precipitate more moisture which has a greater chance of reaching the ground. As it is also generally accepted, that moisture forms a more conductive path for lightning, it follows that dry lightning storms are most apt to be small-cloud affairs, generating lesser quantities of electricity and providing poorer paths for the lightning to reach the ground. Hence the so-called dry storm is less apt to have bolts reaching the ground and therefore may not show a more dangerous percentage than wet storms, even though each bolt from a dry storm may be far more dangerous than each bolt striking from a wet one. Apparently the decrease in striking proclivities is about offset by the increase in ignition probabilities with t net result that while 34% of all wet storms cause fires, about the same percentage of dry storms is also dangerous.

Probably enough data have been given to indicate that the northern Rocky Mountain region does have a serious fire problem in dry lightning storms, that the problem is not as proportionately important as many people may have thought, and that the conditions which control this problem are many and complicated. Other data could be quoted, however, to show that by use of the numerous and well-distributed fire lookouts stationed on the higher mountain tops, a big improvement is being made in our knowledge of both the characteristics and the occurrence of thunderstorms in this region. This research project by the Northern Rocky Mountain Forest Experiment Station has been in progress since 1922 and it is planned to continue it for at least ten years more in order to obtain all possible information, both for forestry and for meteorology.

The Present Status of Scientific Education and How It Came to Pass

(Continued from page nine)

every subdivision of indivisible Science.

And so too of languages—even the so-called classics (Latin and Greek) the *best*. They were doubtless best in their day and no doubt excellent. Maybe, all things considered, they are not best today. At least they do not carry that huge content of knowledge, that profound analysis of things seen and unseen which some of the great modern languages carry.

But do not misinterpret what I say into an attack upon the classics. They too are instrumental and not ends in themselves. They always have been when properly and rightly used. Once

they were the living instruments of two of the world's greatest races. Again they were living instruments for hundreds of years through which and through which alone the world's best thinking was to be done and conveyed to others. They still may be used in a very vital way, and are by no means consigned to the junk heap. They deserve a better place in collegiate and secondary education than they now occupy. But this does not controvert in any way the statement that the half century has displaced them in the position which they once held in the college curriculum, and has replaced them with science.

Constantly we are confronted with statements which in some quarters sink to the place of complaints that the increase in college enrollments has been unreasonably great. The complaint is usually coupled with a growl because of alleged cost. Even a superficial glance at the facts shows clearly the close connection between this increased number and cost and the new basis of collegiate studies and the methods pursued. A vital relation between this knowledge and the community it is to serve is revealed. A further glance would disclose to the most indifferent the fact that the excessive economic gains to the community to say nothing of the greater health and well-being, is incomparably greater than the increased outlay which it involves.

The Sixth Annual Meeting

THE sixth annual meeting of the Northwest Scientific Association was held in Spokane, Washington, on December 27 and 28, 1929. From the standpoint of attendance the meeting was decidedly successful, as there was not only an increase in attendance of members and visitors over previous years, but also an increase in new members. The mild weather which prevailed during the meetings was undoubtedly a factor favoring a large attendance.

The central feature of the general program on the opening day was a symposium on "Encouragement of Research by Institutions of Higher Learning in the Northwest." After addresses on the topic by President Ernest O. Holland, Washington State College; President Charles H. Clapp, Montana State University, and Dr. M. F. Angell, University of Idaho, the members were invited to participate and a very spirited discussion followed, terminated only by the necessity for adjournment.

Other general sessions in addition to the above were the Medical session on the same afternoon, the annual dinner in the evening and the business meeting and luncheon the following day. At the annual dinner the usual address of the Retiring President was given by Dr. E. A. Bryan, Washington State College, on the subject "The Present Status of Scientific Education; How it Came to Pass." At the luncheon President R. T. Hargreaves of the State Normal School, Cheney, Washington, spoke eloquently on the subject "Science and Education."

In both the general sessions of the Association and in the section meetings there was manifested a desire to concentrate an apreciable portion of the activities of the members towards the investigation of problems primarily of the Northwest. The greater part of the program of the Forestry section was devoted to a symposium on Forest Protection in the Northwest and the geology section voted to concentrate on the study of the belt rocks of Idaho and Montana and to make

this topic a center of interest at the 1931 meeting.

Xi Sigma Pi, national honorary forestry society, held its annual convention in connection with the meeting of the Association, an unusually large number of foresters being in attendance at both meetings.

The Council, at its meeting on December 26 set Monday and Tuesday, December 29 and 30 as the dates for the meeting of 1931.

The following officers were elected for 1930—

President—Francis A. Thomson, President State School of Mines, Butte, Mont.

Vice-President—C. C. Todd, State College of Washington, Pullman, Wash.

Secretary-Treasurer—J. W. Hungate, State Normal School, Cheney, Wash.

Councilor for five years, H. N. Putnam, U. S. Blister Rust Service, Spokane, Wash.

Councilor to succeed C. C. Todd—E. F. Gaines, State College of Washington, Pullman, Wash.

Trustee for three years—L. K. Armstrong, Spokane, Wash.

Officers of Sections.

Botany-Zoology: Chairman—F. L. Pickett, State College of Washington, Pullman Wash. Secretary; R. A. Diettert, University of Idaho. Moscow, Idaho.

Chemistry-Physics — Chairman, C. M. Brewster, State College of Washington, Pullman, Wash.; Secretary. J. G. McMacken, Lewis and Clark High School, Spokane, Wash.

Education—Chairman, S. G. Witter, Part Time School, Spokane, Wash. Secretary, Charles R. Randall, Veradale, Wash.

Engineering—Chairman, Ivan C. Crawford, University of Idaho, Moscow, Idaho; Secretary, Richard McKay, Spokane, Wash.

Forestry—Chairman, J. C. Evenden, Bureau of Entomology, Coeur d'Alene, Idaho; Secretary, A. L. Gibson, Bureau of Entomology, Coeur d'Alene, Idaho.

Geology-Geography—Chairman, Eugene S. Perry, State School of Mines, Butte, Mont.; Secretary, O. W. Freeman, State Normal School, Cheney, Wash.

Medicine-Surgery — Chairman Dr. S. E. Lambert, Spokane, Wash.; Secretary, Dr. Donald A, Palmer, Spokane, Wash.

Plant Pathology—Chairman, C. W. Hungerford, University of Idaho, Moscow, Idaho; Secretary, W. H. Pierce, University of Idaho, Moscow, Idaho.

Social Science—Chairman, T. S. Kerr, University of Idaho, Moscow, Idaho; Secretary, Louis S. Livingstone, Lewis and Clark High School, Spokane, Wash.

The art of weaving was known to the Indians who built their mounds in Indiana centuries ago, as it was to their compeeers of the Hopewell area in Ohio and to the greatly different Indian civilizations of the Southwest. On opening a leather pouch containing a number of copper bracelets excavated from the mound he is exploring at Winchester, Indiana, F. M. Setzler found three layers of woven cloth. The Indians knew how to make more than one kind of fabric, for part of the material was finely, part corsely woven. Very little woven work by moundbuilders has come down to us, because in the damp earth of the mounds it had no chance to be preserved from decay. The pieces which have been recovered have, without exception, been preserved by contact with copper objects, which formed verdegris, checking the action of fungi and bacteria of decay.

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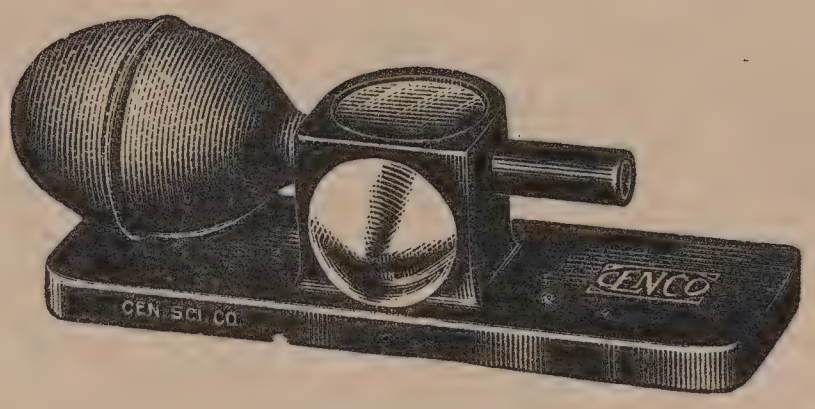

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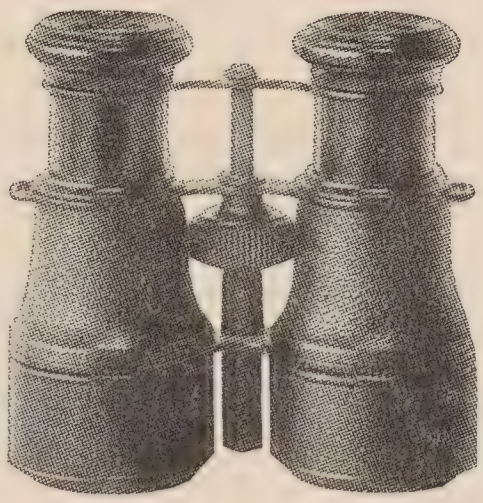

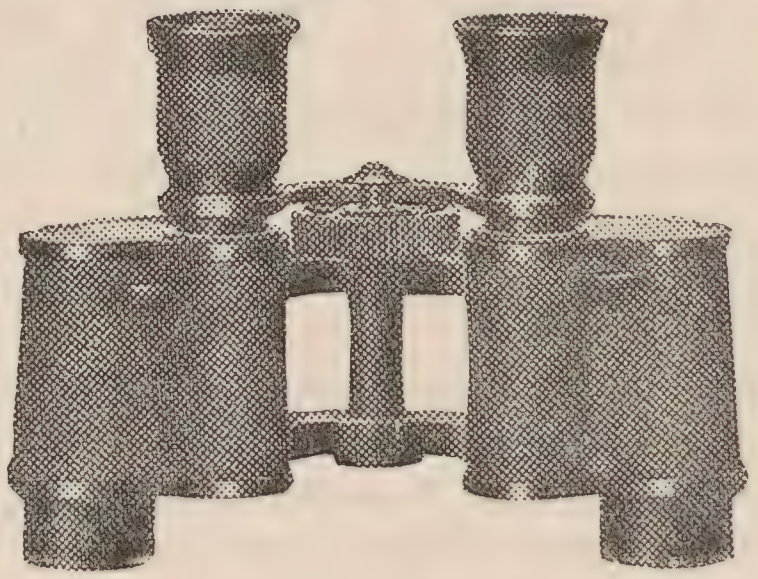

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NORTHWEST SCIENCE

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EDITORIAL

Research and Prosperity

MAN'S research concerning his suroundings and himself dates back to the first experiments with the making of fire and are as old as the race. Man brought nothing of research value into his world and for ages very little was added to this nothing, and such as it was, the research, if it may be so called, developed painfully and slowly. The change in research from then to now is only a matter of degrees, of scale and of precision. The slow development of a stone axe in the early dawn of civilization would appear as child's play viewed from the complex and extensive research activity of today.

Since the World War investigative work in industrial lines has received a tremendous impetus. At that time, the value of research was so forcibly impressed on businessman and public alike that we now view, as a matter of course, the spectacle of more than ten million workers following various phases of investigative work in this country. The labor expenditure alone represented by these workers amounts to a handsome sum and when the investment in capital, equipment, and other charges for research work are added, it is easy to realize the part played in our commercial development by the two million dollars which industrial concerns spend annually on research problems.

All of the large industrial units find that money invested in research pays tremendous dividends and that research is essential to successful competition. Today the automotive industry is competing with radio production and each industry through the medium of research is forced to present the buying public with improvements and innovations. The lumber industry, faced with a score of substitute materials, must meet the changing order and fight back with the weapons of research. The silent film has fallen before the rapid and startling development of the 'talkie," and the silk industry makes way for the advance of a chemical fabric manufactured from cellulose. Synthetic rubber may upset the rubber industry and new products are being placed upon the market with bewildering rapidity. These are but a few instances among a large number.

Research, through the improvement of old, and the development of new processes, contributes more than we appreciate toward the prosperity of our nation. Communities blessed with the progressive spirit encourage industries, educational institutions and other agencies in their midst to follow the lighted path. The Northwest, with its wealth of raw material and natural resources, may well read the signs of the times and lay a foundation of future prosperity built up through sustained research activity.

The Question of Amitotic Division In Flagellates[1]

By
J. McA. Kater,
Department of Zoology, Washington State College

THE early general cytologists regarded amitosis as a reproductive phenomenon involving not only the duplication of the nucleus, but also stimulation of cytoplasmic division. Likewise the protozoolgists of the last century conceded amitosis to be a normal method of nuclear division that was followed by fission of the cell. In fact the latter group has persisted in describing supposed cases of direct division in some of the simple types, where investigation is difficult, down to the present day. It is only in the past few years that authorities in this field have clearly enunciated the amply justified conclusion that mitosis, or a simplified form of it, is the one and only method of nuclear division that leads to cell reproduction (Kofoid, 1923, Kater, 1927.)[1] Of course, it is admitted that nuclei of Protozoa may divide amitotically, but such an occurrence is the result of a pathological condition or a highly differentiated state, just as it is in the cells of Metazoa and Metaphyta, and is not followed by cytodieresis. The present day attitude of the more critical protozoologists can be adequately set forth by a quotation from Kofoid (1923): "In the first place amitosis as described in the Protozoa is either a pathological or degenerative process, as it is in the Metazoa, or it is based on a partial account of the normal process of mitosis in which the nuclear membrane remains intact throughout the whole process, as it does in the flagellates and rhizopods, and in its anaphases presents a superficial resemblance to pathological amitosis. The persistence of the nuclear membrane in no way interferes with the occurrence of chromosomes constant in number and kind. In other words, the doctrine of chromosome continuity, in so far as amitosis is concerned is no more affected in Protozoa than in Metazoa."

Even though we consistently find textbooks that refer to amitosis as a reprouctive phenomenon in Protozoa, when we examine the original papers responsible for the conclusion, we find that it is based upon extremely flimsy evidence and in many cases the authors themselves were far from being completely convinced that the nuclear division which they described was actually followed by fission. Wenrich (1924[2]) says, "In the pellucid variety there is a marked tendency for the nucleus to hypertrophy. It expands so as to approximate the diameter of the body and then elongates along the axis. This hypertrophy is accompanied by a multiplication of the caryosome, as many as four having been found in one nucleus (Figs. 12 to 16). Hypertrophy apparently leads to amitotic division of the nucleus (Figs. 32 to 35), which is probably followed by division of the cell body (Fig. 36)." The author neither observed actual fission following amitosis in living organisms nor did he find unmistakable evidence for such a conclusion in his stained specimens. In view of that fact the statement of his conclusion as a probability is, perhaps, somewhat too strong, and the usual textbook quotation of such conclusions as facts is, of course, wholly unjustified.

Belar (1916)[3] has described amitotic division in *Chilomonas paramecium*. His figures are quite convincing, so far as the division of the nu-

1. Presented at the annual meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Wash.

cleus is concerned. He regards it as a pathological process, because the resulting cytoplasmic division, which can frequqently be followed almost to completion, is almost always unequal. He considers the fact that the cultures in which this phenomenon was observed always varied greatly in size to be convincing evidence for the conclsion that the fission is completed.

While culturing *Chilomonas* my attention was quite accidentally attracted to a variability in the size of the organisms which was more or less determined by the age of the culture. In relatively old cultures they are much larger than they are in younger ones. As the heavy scum of zooglea is formed the *Chilomonas* becomes collected and enclosed within it in great numbers. Here they cease the usual active swimming movements, in some cases losing their flagella, and gradually enlarge for a period that may last several weeks. The increase in width is greater than the increase in length. Accompanying the enlargement is a collapse of the walls of the characteristic cryptomonad gullet, leading to its complete disappearance in some individuals. The body proportions of the normal and pathological types are represented in Figure 1. These alterations were sufficiently str king to suggest further observation.

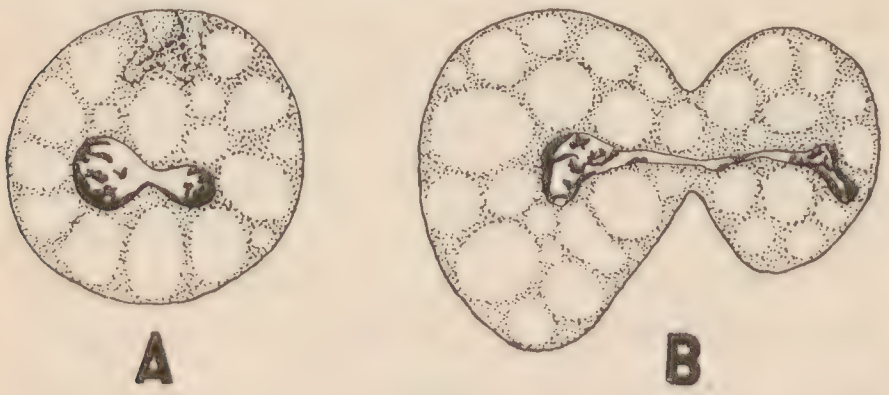

FIG. 1. A Normal *Chilomonas;* B Pathological specimen from old culture; X 1500.

At first I did not feel sure that the cultural conditions were entirely responsible. So subcultures were made from the enlarged type and were found, in all cases, to give rise to perfectly normal individuals. This would seem to indicate that up to the moment of death, they are genetically unaffected.

Some of the pathological type were fixed and stained. Great was my surprise to find that, although the size of the cell body had increased, the size of the nucleus had greatly decreased. (*Fig.* 1.)

And greater still was my surprise to find many amitotic divisions. *Fig. 2A*). In some cases cleavage of the cell was almost completed also. (*Fig. 2B*). Not a single mitotic figure was found.

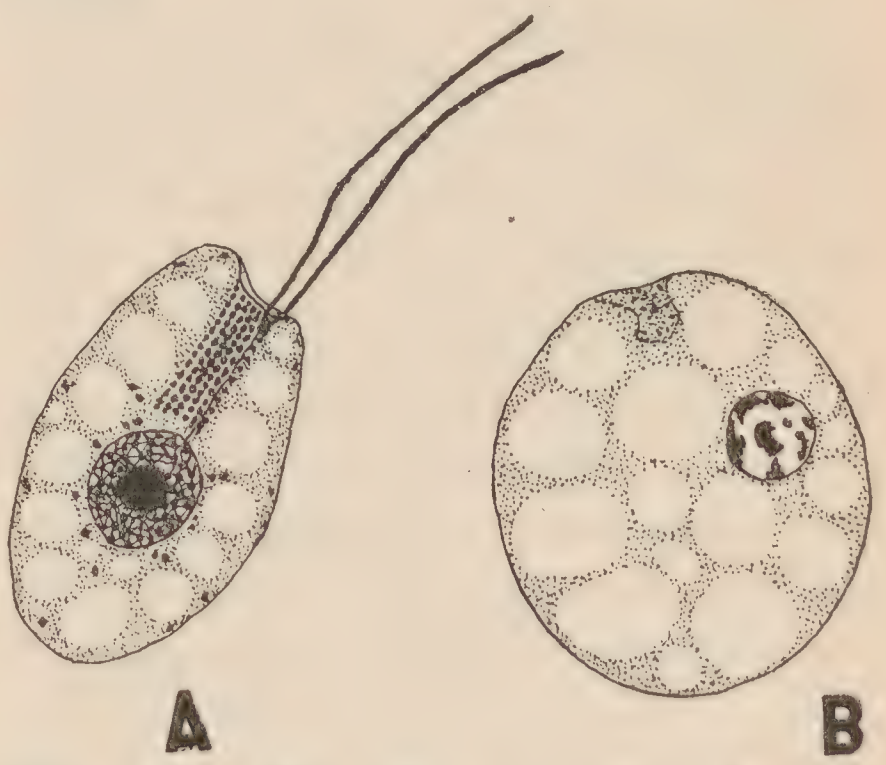

FIG. 2. A. Early stage of amitosis; B. Later stage of amitosis; X 1500.

Although in no case was the constriction of the nucleus completed the cytoplasmic clevage so nearly approximated completion that I was almost led to conclude that, in this pathological state, amitosis resulted in cell division, Belar's conclusion. However, I saw no reason for being satisfied to leave the matter unsettled when it was possible for patient observation to absolutely establish or refute the idea. Accordingly, I returned to living material. All told I have selected and watched several dozen specimens that were in late stages of fission. In not a single case was division completed. The process would proceed to the point when it seemed as though fission would be completed and then cytolysis would occur, leaving behind only a few amyloid bodies. By selecting

for observation only individuals in which fission was well advanced it was generally possible to observe cytolysis within a quarter of an hour and in no case was more than an hour of watching necessary. To obviate the criticism that cytolysis was due to the condition of the mount it is well to mention that in all of the mounts many undividing pathological specimens were present and none of these liquefied. This, it seems to me, amply justifies the conclusion that, even in the pathological state observed in these cultures, amitosis is never followed by cytodieresis, although cytokinesis proceeds for a brief period.

No photozoologist is justified in doing more than suggesting, as a slight possibility, that amitosis is followed by fission, even in pathological states, unless he has observed fission proceed to completion in living organisms.

Some incidental observations also seem worthy of recording. When the typical vesicular nucleus of *Chilomonas* become shrunken in the hypertropied organisms the chromatin reticulum becomes much distorted, the chromatin frequently becoming aggregated in a few clumps that are distributed around the inside of the nuclear membrane (*Fig.* 3). In addition the metachromatic granules, which occur in great numbers in the vicinity of the gullet, disappear. (*Fig.* 1.)

Twenty-five camera lucida outlines of longitudinal optical sections of cell body and nucleus of normal and hypertrophied individuals were made and their area calculated with a planimeter. The average area of the normal cell body is 104 square micra and of hypertrophied cell body is 121 square micra. In case of the nucleus the ratio is reversed, the normal ones having an area of 13 square micra and the pathological ones having an area of 9 square micra. This suggests an interesting permeability relationship. The degeneracy involved apparently increases endosmosis in the cell and exosmosis in the nucleus.

SUMMARY

In old cultures of *Chilomonas* where degeneration has been initiated the cell body becomes greatly enlarged and the nucleus shrunken. The nucleus attempts to divide by amitosis and fission of the cell is initiated but neither is ever completed. Thus, Belar's conclusion that pathological specimens may divide amitotically is refuted. This affords an addition to the already large amount of evidence that mitosis or a simplified form of it is the universal method of cell reproduction.

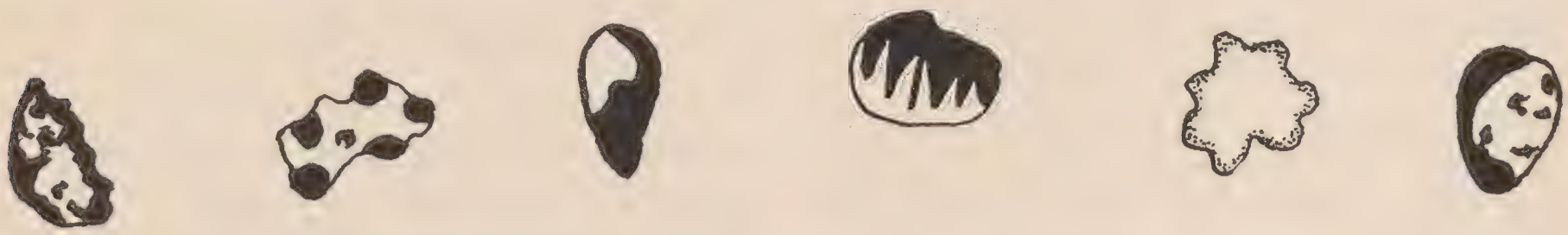

FIG. 3. Drawings showing nuclear structure in various pathological specimens.

[1] KATER, J, McA., 1927. Cytology of *Saccharomyces cerevisiae* with especial reference to nuclear division. Biol. Bull., 52,

[1] KOFOID, C. A., 1923. The life cycle of the Protozoa. Science, 57.

[2] WENRICH, D. H., 1924. Studies on *Englenamorpha hegneri* N.G., N. Sp., an euglenoid flagellate found in tadpoles. Biol. Bull., 47,

[3] BELAR, K., 1916. Protozoenstudien. Arch f. Protist., 36.

Pest Control Activities of Federal Plant Quarantine and Control Administration[1]

By C. R. STILLINGER
Associate Pathologist, Spokane, Wash.

THE economic importance of plant pests to the specific infested locality and to the nation as a whole, depends on the virulence of the pests, the distribution of their hosts and the importance of these hosts. We must awaken to the national concept of plant pest control. If a pest becomes established in a community on a commercial crop, it is important, not only to the immediate community, but also to all other communities which grow the same crop as well as to the consumer of that crop. Those communities which are not suffering from a particular pest established in another community should be vitally concerned whether action is being taken against the pest.

The Douglas Fir disease in Massachusetts is of little economic importance to that State but would undoubtedly cause a serious drain on our forest resources if it becomes established in the West. The Satin Moth, Japanese Beetle, Gypsy Moth and Brown-tail Moth constitute threats to this western region and they must be kept from spreading to this area as long as possible. As consumers we should be vitally concerned that the Mediterranean fruit fly eradication work is pushed to the limit. Indeed, is the public not justified in demanding that all plants which are moved from one community to another are free from pests of any kind? I believe that pathologists and also entomologists, as scientific men, should be the leaders in practical applied entomology and pathology and should give more attention to quarantine and inspection methods.

The subject is a large one. Phases which might be discussed are the history and development of State inspection work, the legal phase of quarantine and inspection, the aims and purposes of quarantine and inspection, methods and systems of inspection, the transportation systems of the United States as channels of distribution of pests, the results of the inspection work, the training of the inspector, the importance of his work for controlling pests, the effect of quarantine on trade, the responsibility of the Federal government and the State in the control of pests, and finally, pest control on a national scale, or in other words, the responsibility the Federal government is assuming in preventing the spread of pests. The subject is so extensive, that I find it necessary to limit myself to one phase of these problems and will, therefore, present only a general outline of the pest control activities being carried on by the Plant Quarantine and Control Administration.

Authority for quarantine and regulatory work by the United States Department of Agriculture is granted by the Plant Quarantine Act of 1912, an act which, strengthened by certain amendments, is still in force.

The Secretary of Agriculture is authorized by that act "to regulate the importation of nursery stock and other plants and plant products; ** to establish and maintain quarntine districts (on account of) plant diseases and insect pests; (and) to permit and regulate the movement of fruits, plants and vegetables therefrom." This act created the Federal Horticultural Board as the agency to execute the provisions of the act.

[1] Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 28, 1929, Spokane, Wash.

That Board carried the responsibility for enforcing the Plant Quarantine Act from the time the Act was passed in 1912 until 1928. Its duties have included the preparation of quarantines and regulations for the Secretary's consideration and the administration of the port inspection and foreign quarantine services. It has also directly administered the domestic plant quarantines relating to cotton pests and the date palm scale insects, respectively, and has enforced the Insect Pest Act of 1905 and certain other

Other regulations governing interstate movements have been administered by the Bureaus of Entomology and Plant Industry in cooperation with the Board. The Bureau of Entomology has been in charge of work relating to the Gypsy moth, European corn borer, Japanese beetle, and certain other important pests. The Bureau of Plant Industry has administered and enforced the White Pine Blister Rust Quarantine.

For several years, however, the United States Department of Agriculture has been working toward a separation of the research work from the regulatory activities in which it is engaged. The first general move of this kind consisted of the establishment of the Food, Drugs and Insecticide Administration to relieve the Bureau of Chemistry of its law enforcement responsibilities and to combine the work of the former Insecticide and Fungicide Board with that of the enforcement of the Food and Drugs Act. That change became effective on July 1, 1927.

Following the same policy, the Secretary of Agriculture two years ago, recommended to Congress that all the regulatory work connected with the "control and prevention or spread" of insect pests and plant diseases affecting the agricultural, horticultural and forest resources of the country, be combined under one organization. This recommendation was adopted and a new bureau known as the Plant Quarantine and Control Administration was organized in the Department. The new administration is, in a sense, the successor to the Federal Horticultural Board.

As a result, effective July 1, 1928, all these activities of the Federal Horticultural Board as well as those carried out in other bureaus for and under the authority of the Federal Horticultural Board, have been centered in the Plant Quarantine and Control Administration. Mr. Lee Strong, formerly assistant director of agriculture of the State of California, is now chief. A "Federal Plant Quarantine Board" of five members has been appointed to act in an advisory capacity to the Administration.

The technical and scientific work of the administration is divided into two major subjects, viz; (1) the enforcement of foreign plant quarantines and (2) the enforcement of the pest-control and spread-prevention operations in relation to domestic quarantines on subjects authorized from time to time by Congress.

The first major project is responsible for the enforcement of quarantines prohibiting or regulating the entry of foreign plants and plant products, with the object of preventing the entry into this country with such products of new and dangerous plant pests, either insect enemies or plant diseases. The functions of this division are to enforce (1) the 23 foreign quarantines and regulatory orders issued under the plant quarantine act of 1912, involving (a) issuance of permits setting forth conditions of entry of plants and plant products, (b) inspection and if necessary, disinfection for pests, of plants and plant products arriving under permit at the ports of entry, (c) inspection of parcel-post packages for contraband material and the inspection of passengers' baggage,

crews' quarters, and ships' stores for similar material, (d) field inspection of plants imported under special permit agreement, and (e) inspection and certification of certain fruits and vegetables produced in Hawaii and Porto Rico for shipment to the mainland; (2) the rules and regulations governing the entry into the United States of railway cars and other vehicles, etc., from Mexico; (3) the act of 1905 governing the entry of living insects; and (4) the export certification act providing, when required by foreign countries, for the inspection and certification of fresh fruits, vegetables, seeds, and nursery stock and other plants for propagation.

The second major project is responsible for the establishment and maintenance of quarantine districts within the United States for the purpose of preventing the spread of insect pests or plant diseases which may have gained local foothold, and cooperating with the States in measures looking to the extermination of such pests.

Under this branch of the work various large-scale field operations are carried out under special appropriations from Congress, with the object of controlling or preventing spread and, in some instances, effecting the extermination of the pest concerned. This applies to such subjects as the corn borer, Japanese and Asiatic beetles, gypsy moth and brown-tail moth, Thurberia weevil, pink bollworm of cotton, date scale, Mexican fruit worm, and Mediterranean fruit fly.

This in brief gives an outline of the activities of this new bureau. A discussion of any one of these numerous projects would be of interest. I have chosen to discuss more in detail the project with which the Spokane office of the Bureau is engaged, that is, transit inspection.

Express, parcel post, and freight shipments from any particular point in the United States destined to any other point follow certain prescribed and predetermined routings. Nearly all shipments to any great distance will be found to pass through certain distribution points. It is almost impossible, for example, for interstate shipments of any kind from East to West, or West to East, across the upper Mississippi Valley to avoid passing through one or more of the points of St. Paul, Omaha, Council Bluffs, Kansas City, and Chicago. At each of these points it must usually change railroad. Inspectors stationed at those points can work out schedules by which practically all such shipments may be seen at some time during the transfer process.

At more important distribution points, the inspection problems are intensified by the large number of railway stations, post offices, and freight yards in the city. At Chicago, where more interstate shipments are transferred than anywhere else in the country, there are fifteen express, ten mail, and two hundred fifty freight inspection points. By a careful study of train schedules, distribution routes, and the territory through which trains run, it has proven possible for four or five inspectors to see practically all plant shipments moving through the city by mail or express. The railroads have been cooperating in connection with freight by furnishing copies of waybills of nursery stock shipments from one to four days in advance of arrival. It is thus possible for the inspectors to determine which freight shipments they desire to see and make only such visits to freight stations as are necessary.

The adoption of transit insepction resulted originally from the investigation of the County Horticultural Inspectors reports of the State of California during the fall and winter of 1919. These records of interceptions revealed that the Federal Blister Rust

(Continued on page 44)

Conservation of Hearing[1]

DR. F. C. HARVEY
Physician, Spokane, Wash.

GREAT sayings have lived and come down to us because they have expressed eternal truths. And so Paul, that great biblical writer, expressed an eternal truth, when he set forth how the body, composed of many members, is as one. "And the eye cannot say, unto the hand, I have no need of thee" "Nor the head to the feet, I have no need of thee." But for unity of purpose and action all are of equal importance. The loss of even the smallest member, sends us out into the race of life with a serious handicap.

We can all appreciate what it means to be blind or deaf! And so for many years, we have had schools established, where the blind child can be trained, and the deaf child equipped for life. But not until recent years, have we given serious attention to that great army of children, who have passed and are passing through our schools and out into life, handicapped, as they are with defective hearing in one or both ears. Experts tell us there are from five to ten millions of this class in the United States.

If this be true, is it not time that we gave serious thought and attention to this great problem of conservation of hearing? In order to understand better the causes of defective hearing, let us look briefly into the anatomy of the ear. The ear is divided into three parts; (1) the external ear, composed of the pinna and external auditory canal; (2) the middle ear, composed of the drum membrane, the ossicles and the eustachian tube; (3) the internal ear, composed of the labyrinth and semi-curcular canals.

In the external ear, the commonest causes for defective hearing are, boils and other acute inflamations of the canal, hardened wax and foreign bodies, such as peas, beans, small stones, bugs, etc. These are the least serious, and the most satisfactorily treated. Diseases of the internal ear are, the least amenable to treatment but fortunately they occur in later life, and so do not affect our conservation program so much.

Diseases of the middle ear are the most common and the most serious of all. They are the direct result of infections from the nose, and throat, through the eustachian tube. The most frequent causes are the infectious fevers as measles, diphtheria, scarlet fever, etc., and the infectious of the upper respiratory tract, such as influenza, and tonsilitis. Probably the worst offender of all is the common cold. Enlarged tonsils and adenoids are contributing causes. It is from the acute infections of the middle ear that the mastoids develop, and these are also a threat against the life of the individual.

A large percentage of middle ear diseases are curable, if taken in time; and the cases which result in permanent impairment of hearing are usually of the neglected and progressive type.

The keynote in medicine today is prevention, and one of the greatest aids, is the periodic health examination. Conservation of hearing presents to us a problem in preventive medicine. The greatest link in this chain is the early recognition of defective hearing in our children and the institution of the proper preventive and remedial measures. "A case that is easily curable today, becomes hopelessly in-curable next month or next year."

We have in the schools of our coun-

1. Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Wash.

try some twenty-four millions of children. Of these about three millions have defective haring in one or both ears. The first step, which makes conservation of hearing possible, is the periodic testing of the acuity of hearing of these children. This has been the great obstacle which has held up for so long the conservation of hearing program. And it is only within the last few years, through the perfecting of the phone-audiometer that this has become possible. This was brought about by the combined efforts of the American Federation of Organizations for the Hard of Hearing, founded by Dr. Wendell Phillips of New York, and associated leagues, and the experts of the Bell Telephone Company.

By the old methods it was only possible to test fifteen children per hour, while now with the phone-audiometer one hundred to one hundred and fifty can be tested in an hour. More minute losses of hearing can be detected and can be detected from five to ten years sooner, than it could be discovered by those with whom the child has ordinary conversation. Since the advent of the audiometer, leagues have been established in seventy cities, under the leadership of educators, physicians, and social workers, for the periodic testing of the acuity of hearing of school children. Including last year, about half a million children had been tested through these agencies.

After the testing is completed the second step in the program is the treatment; this is both preventive and remedial. The preventive treatment consists of health talks to parents on the care of their children's ears, building up their resistance with a well balanced diet, plenty of fresh air, sunshine, and exercise and guarding them against colds. Giving them normal noses and throats as far as possible, by the removal of tonsils and adenoids, also aids greatly.

Those whose hearing is already affected should receive the proper treatment for their ailment. Eighty per cent of the cases are curable by early diagnosis and treatment.

What of the other twenty per cent who are not curable? Besides having their condition properly treated, theirs is an educational program. There are many devices as aids to hearing, but the simplest and best of all is to have the child with incurable defective hearing taught lip-reading.

Special classes should be established in our day and night schools for this purpose, adn we should have teachers specially trained to understand the educational needs of these children. It is far better to treat this class of children, in special classes in our schools, rather than in special schools for the deaf; and it costs much less.

Someone has said, "Childhood deafness means adult tragedy:" it means individual distress, mal-adjustment, non-employment and economic loss both to the individual and the community. Our school boards should take note of these facts. At Fort Worth, Texas, last year twenty thousand children were tested, there were 729 grades repeated. Professor Moore, Superintendnt of schools, estimated that it cost eighty dollars extra for every grade repeated, or a total of $58,300 to the city. Defective hearing in children is one of the chief causes of grades being repeated.

In the seventy cities of our country where organizations have been formed and the conservation of hearing program has been carried out in a systematic manner, miracles have been happening as exemplified in the following quotation; "The languid and helpless child has become alert and hopeful."

"The difficult child finds out his possibilities for growth and development." Oftimes the so-called stupid child becomes the star pupil, and the

(Continued on page 47)

Are the Brightest Young Men and Women Leaving the Farm?[1]

By
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Washington State College

THIS study was made to determine the extent of farm migration from the three communities studied, what the reasons are for the migration of farm folks to the city, and whether the migration has been selective in its effect upon the rural population.

The data for the study were gathered during the summer of 1928, in Columbia, Kittitas, and Skagit counties, in the State of Washington. A family schedule was used in gathering the data. Five hundred and fifty-two families were visited and information received concerning 1,996 persons, 16 years of age and over, either living on the farm or having left the farm. Other facts were gathered from leading men in these three counties and from the United States census reports.

Extent of Migration

Approximately 16 per cent of the male members of the families that were surveyed had left the farm, whereas 22 per cent of women had left the farm. A larger percentage of females migrated to the city than males.

This is partly explained by the fact that the farm offers very little opportunity for the single woman. Then, too, many have the ambition to enter a profession. The percentage of both males and females that had left the farm was 18.9.

As a result of this migration the city gains in population and productive power, but the rural communities, after having stood the expense of educating and raising these boys and girls, lose them at the time when they are ready to enter upon their most productive period.

Another effect of this migration is that it takes the most vital element of a community. Most of the migrations take place during the age period from 16 to 30 when people are in their "prime." This leaves in the country a population in which children and old people predominate.

Age at Which Men Migrated

Of 147 males migrating, whose age at the time of leaving the farm was known, the great majority left before they were 30 years of age.

By far the largest number of males leave the farm during the age group from 20 to 30.

Occupations After Leaving Farm

Of the 165 males who had left the farm, information was received for occupations engaged in by 121. The largest number of these are laborers. Probably the largest percentage of those listed as miscellaneous should be under the laborer's division.

The professions, which include teachers, ministers, doctors, etc., rank second in number. Mechanics, clerks, and merchants come next in their respective order. Approximately 70 per cent of the females who have left the farm are married. The chief occupations entered by the unmarried women who have left the farm are teaching, nursing, clerking, and secretarial work.

Reasons Given for Leaving the Farm

The most difficult task in the whole survey was to find the real reasons

1. Presented at the annual meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Wash.

why people left the farm. The surveyor asked the parents or kinsmen of people leaving the farm why these people had left, and recorded the reasons given. Not being satisfied as to the accuracy of the answers given, a personal letter was addressed to approximately 30 per cent of the people that had left the farm, asking them to give their reasons for leaving. In the case of the women it was extremely difficult to get the reasons for their leaving the farm because a great majority of them had married men living in the city, and other women who had left and were not married had not all taken up permanent residence in the city.

In checking th reasons given by 32 men who answered the letters sent out to them, it was found that 21 out of the 32 gave the reason or reasons given by their parents or kinsmen for leaving the farm, whereas 11 of the 32 did not give the same reason given by their parents or kinsmen.

Reasons for leaving the farm given by the 21 males whose answers agreed with the answers given by parents or kinsmen in the order of times mentioned were as follows: could make more money in the city, 10 times; did not have capital to begin farming, 7 times; lacked land with which to begin farming, 7 times; poor health, 5 times; other interests more appealing, 4 times; better social life in the city, 1 time; wife preferred city, 1 time. Reasons mentioned by the 11 whose answers did not agree with answers given by parents or kinsmen were: did not have capital to begin farming, 6 times; could make more money in the city, 5 times; lacked land with which to begin farming, 3 times; other interests more appealing, 2 times; poor health 1 time; wife preferred city, 1 time.

Reasons given by the 30 women who answered the letter sent out to them were: marriage to some one other than a farmer, 15 times; could make more money in the city, 9 times; other interests more appealing, 8 times; poor health, 4 times; lacked capital to begin farming, 3 times; disliked farming, 3 times; better social opportunity in the city, 2 times; lacked land with which to begin farming, 1 time. The main reason for the women leaving seems to have been because they married some person living in the city. This is further substantiated by the records taken from the kinsmen which show that over 70 per cent of the 213 women who had left the farm were married.

Farm Work and Rewards

The average age at which males who remained on the farm began full time work is only slightly higher than for the males who left the farm. The males who left the farm on the whole had to begin work a little earlier than the males who remained on the farm. The males who have remained on the farm were given more opportunity to work out on a neighbor's farm where they could earn more money of their own.

The males who left the farm did more chores. Chores are disliked by many boys and the evidence seems to show that too many chores was possibly one of the factors causing the boys to leave the farm. Milking and the care of stock were the two most common chores done by the boys.

A higher percentage of the males who remained on the farm were allowed a share in the crops and stock before they were 21 years of age. A higher percentage of the males who remained on the farm were allowed to help in the planning of the farm work before they reached the age of 21. The males who remained on the farm did not work quite as long hours as the males who left the farm.

The figures show that 6.6 per cent of the males remaining on the farm received wages from their parents be-

fore they were 21 years of age and 12.2 per cent of those leaving the farm had received wages from their parents before this age. These facts, however, may indicate another thing which was discovered in a good many cases, and that is that the boys who disliked farming and had other interests were paid wages by their parents in order to hold them on the farm. This may account for the fact that a higher percentage of the males who had left the farm were paid wages before they were 21 years of age.

Recreation and Amusements

There is a slight difference in the two groups, in the average number of times that persons within the groups go to town for amusements. For people still living on the farm reporting times going to town per week for amusements, there was an average of 2 trips per week Those who had left the farm had gone to town an average of 1.7 times per week, while living on the farm. Persons who remained on the farm attended movies or theaters an average of 2.1 times per month. Those who had left the farm attended movies or theaters an average of 2.9 times per month, while living on the farm. The suggestion might be made here that perhaps one of the factors causing persons to leave the farm is the creation of new desires, although no doubt the natural desires of many young people born on the farm would lead them to prefer the attractions of the city. The figures on the average times per month that persons in the two groups attend dances or socials correspond somewhat with the figures on movies and theaters. People that remained on the farm attended an average of 1.5 dances or socials per month. Those leaving the farm attended an average of 2.0 dances or socials per month while on the farm.

In the case of the persons remaining on the farm, 53.9 per cent, held membership in some church. For those leaving the farm only 51.5 per cent belonged to some church while living on the farm. There does not seem to be much difference in the percentage of membership between the two groups.

Home Conveniences and Amusements

In six out of the seven types of home conveniences and amusements the group that had left the farm had a higher percentage of these conveniences or amusements while on the farm than those people who had remained on the farm.

Of persons who have remained on the farm, 35.1 per cent, had running water in their homes. For those who had left the farm, 45.3 per cent had running water in the home. The difference in percentage here is considerable. Of persons remaining on the farm, 28.4 per cent, had electricity in their homes for light and power. In the case of those leaving the farm. 38.7 per cent, had electric lights. This is considerably higher than for those who remained on the farm.

Another convenience which has come into use only recently to any large extent. is the automobile. Of the people who remained on the farm, 31.9 per cent, had an automobile in the family before the persons were 20 years of age. Of the people who had left the farm, 57.9 per cent, had a car in the family.

It seems to be relatively safe to draw the conclusion from these data that it is the boy and girl that lives in the more fully equipped type of home in so far as conveniences and amusements are concerned that leave the farm. The boy and girl from the home with less conveniences and amusements has not the opportunity to get an education and prepare for another vocation that the boy and girl from the home better situated financially has. This, however, does not mean that the most intelligent boy or girl leaves the farm and the others

stay, as we shall see in the next section.

Reading Matter in Homes

In practically all cases the group of persons leaving the farm had a larger percentage having different kinds of reading material in their homes. Not only did the persons who had left the farm have more reading material in their homes, but in all but two of the cases a larger percentage of them read the different kinds of material.

Of the persons who remained on the farm, 77.9 per cent, had access to a local weekly paper in their homes before they were 20 years of age. In the case of the group that had left the farm, 88.0 per cent, had access to weekly papers in their homes while on the farm. The figures on the percentage having access to and reading daily paper show the same tendencies, as the figures for the local weekly paper. Of persons who remained on the farm, 48.2 per cent had access to a daily paper in their homes. Of persons who had left the farm, 81.1 per cent, had access to a daily paper in their homes. Of persons who remained on the farm, 35.0 per cent had access to boys' or girls' magazines in their homes. In the case of the group that had left the farm, 46.5 per cent, reported reading boys ' or girls' magazines in their homes while on the farm. Even in the number and percentage of persons taking and reading farm papers, the persons who had left the farm had a higher average than those who had remained on the farm. With regard to books and magazines for adults, those leaving the farm had had better advantages than those remaining on the farm.

On the whole, the evidence shows that the persons that had left the farm came from the homes where reading matter was more abundant than in the homes of those who remain on the farm. Also those that had left the farm did more reading. It would seem that a larger percentage of the boys and girls from the better homes, judging by the amount of the reading matter and their reading, had left the farm.

Average Years Attended Grade School, High School, and College

The persons who remained on the farm completed an average of 7.5 years each in the grammar schools. Persons who had left the farm attended grammar school an average of 7.4 years. The difference in percentage attending grammar school and average grades completed between the two groups is almost neglible.

For the attendance in high school the difference is quite marked between the two groups. Of persons who had remained on the farm, 44.7 per cent, attended high school. These people attended high schools an average of 2.7 years each.

Of persons who had left the farm, 61.3 per cent, attended high school. These persons attended an average of 3.2 years in high school. These figures show that those boys and girls that have left the farm had considerably more high school training than those boys and girls who remained on the farm.

On the whole, the figures show that a larger percentage of the boys and girls who left the farm had attended college and the average number of years that they had attended was also higher. Of persons who had remained on the farm, 11.7 per cent, had attended college. These persons attended college an average of 2.0 years.

For those who had left the farm, the figures show that a higher percentage had attended college and on the average they had attended college longer than those that remained on the farm. Of persons who had left the farm, 20.6 per cent, attended college. These persons had attended college an average of 2.6 years.

The evidence on the whole, regarding high school and college attendance, seems to indicate that the greater percentage of the boys and girls who left the farm had better educational opportunities than those who remained. This fact seems to indicate that farm migration is somewhat selective in so far as it is taking a larger proportion of the better trained boys and girls from the farm.

Comparative Ability of the Two Groups

Data were also collected on the comparative ability of those remaining on the farm and those leaving the farm. In the State of Washington every boy and girl who graduates from the eighth grade must take a standard state examination. The records of these examinations are available at the county seats. The records of 317 persons, taken from these eighth grade examinations that are given each year, were obtained. The records extended over a period of approximately twenty years and included 213 persons who had remained on the farm and 104 who had left the farm. The average grade for those leaving the farm was 84.1, while the average grade for those remaining on the farm was 85.5.

This evidence shows that the boys and girls of these three communities who enter high school and college and train themselves for some other profession and then, having the opportunity, leave the farm, are not necessarily the brightest group on the whole. If those who remained on the farm had gone to high school and college they would doubtless have made just as good a record as those who attended these institutions. As was shown in a previous section, it is the boy and girl from the better situated homes, judging by home conveniences and luxuries that leave the farm. This, however, may not mean that they are the most intelligent. The evidence from these three rural communities indicates that there is no reason why we should be pessimistic about the future of the rural communities. As well equipped high schools come into all the rural communities and a college education becomes available to more young people who remain on the farm, the evidence seems to indicate that other things remaining equal, the quality of our rural communities will not suffer in the future from the migrations of farm folks to the city.

Conclusions

1. Out of a grand total of 1,996 persons studied, 378, or 18.9 per cent, had left the farm and migrated to the city. The per cent of males migrating was 16.0, and the per cent of females, 18.9.

2. The age at which persons migrate varies. Most of the migration occurs before the age of 30.

3. The largest percentage of the persons that migrate either the professional or the laboring classes, which fact seems to indicate that the two extremes so far as occupational status is concerned leave the farm.

4. The reasons for the migration to the city as given by the persons migrating are largely economic. By far the largest number of persons left either because they did not have the means to begin farming for themselves, or because they thought they could make more money in the city.

5. In practically all cases the males who had left the farm were at a slight disadvantage in various phases of farm life as compared with males who had remained on the farm. The boy that remained on the farm, he had less chance to work away from home and earn his own money, and he had more chores to do. A slightly smaller percentage of those leaving the farm were allowed a share in the crops and stock and allowed to help plan the farming, and on the whole they

worked longer hours in the field during the busy season of the year. Only in the percentage paid wages before 21 and in the average months worked as busy season did the boy leaving the farm have the advantage. The evidence on the whole seems to indicate that these things are perhaps a smill factor in influencing boys to leave the farm.

6. The persons leaving the farm participated in more social activities on the whole, but were at a disadvantage when it came to having Saturday afternoons off. The evidence seems to indicate that the person who attends movies and social activities most often is the person that is most likely to leave the farm.

7. A higher percentage of persons leaving the farm had had modern conveniences and amusements in their homes. It seems to be the persons from the better equipped farm homes that leave the farm. This type of person has more opportunity to become acquainted with those conveniences and amusements which are most prevalent in the city, and hence may be drawn to the city where he can share in them more readily.

8. In nine out of the ten types of reading material considered, persons leaving the farm were more fully supplied. A higher percentage of their number read the material. This fact seems to indicate that those persons who read most leave the farm.

9. Of those attending high school, the boys and girls that left the farm continued in high schools longer than those that remained on the farm. The same was true regarding college attendance. This would seem to indicate that the average amount of education for those that leave the farm is greater than for those that remain. This does not necessarily indicate that the boys and girls with the greatest natural ability leave the farm but may be due to the fact that those who plan to leave the farm continue in schooi ionger in order to fit themselves for occupations in town.

10. The average grade made by 104 persons leaving the farm and 213 persons remaining on the farm, in their eighth grade state examinations, shows that the persons remaining on the farm had a slightly higher average, 85.5 for those remaining on the farm as against 84.1 for those leaving.

11. The study of farms migration in these communities indicates that there is no ground for the fear sometimes expressed that the farm migration to the city is noticeably selective, taking the most mentally alert to the city and leaving the most mentally inalert on the farms.

12. It would seem that the farming communities can contribnute a fairly large number of persons of superior ability to the cities and still have enough persons of similar talents to maintain a progressive and virile community life in the country.

13. In the light of the above facts we suggest that the social problem of rural communities is not how to keep a higher percentage of their young people on the farm, but to provide the richest opportunities for the growth and development of young people who will remain on the farms through (a) efficient elementary and high schools with modernized courses of study that train for farm life and broad citizenship, (b) opportunities for college education, (c) progressive rural churches, (d) boys' and girls' clubs that develop a vital interest in problems on the farm life, and (e) farm organizations and social facilities that provide wholesome amusements and educational programs.

Dana Jackson Leffingwell

We are saddened by the death on March 7, 1930, of our friend and co-worker, Dana Jackson Leffingwell, losing thereby a most promising investigator in the field of zoology.

Doctor Leffingwell came to the State College of Washington in 1926 as Assistant Professor of Zoology and Curator of the Charles R. Conner Museum. He received his training at Cornell University from which institution he was given the doctorate in philosophy in 1926. His greatest interest was in the field of ornithology, particularly the study of game birds, although this interest was actually extended to all branches of natural history.

"The Ringed-neck Pheasant—Its History and Habits," prepared by Doctor Leffingwell, was the initial publication of a new series, Occasional Papers of the Charles R. Conner Museum, in which it is hoped that much information on birds and animals of the Northwest will eventually be published.

Doctor Leffingwell was in charge of the Grouse Investigation Committee in the Northwest for the American Game Protective Association and had gained considerable information along this line. He had published one paper, "The Grouse Situation in the West," in 1929 in "American Game" on this subject.

He was a keen student of wild life and of conservation. For the last three summers he had been employed by the New York State Conservation Commission, engaged in making a survey of the food resources of the streams of that state. Before coming to the State College of Washington, he was secretary of the Tompkins County Isaac Walton League and was instrumental in the formation of the Pullman local chapter, becoming its first president.

Zoological Publications

By D. J. Leffingwell

1. 1922—The Glaucous Gull at Ithaca, N. Y. Auk, 140:526. Co-author with Freidmann, Herbert.

2. 1925—Connecticut Warbler in Spring Migration in Central New York. Auk, 140.

3. 1925—Mockingbird in Central New York. Auk, 142:140-141.

4. 1926—A Preliminary Biological Survey of the Lloyd Cornell Reservation. The Streams, Bul. No. 27, Lloyd Library, Cincinnati, Ohio, pp. 17-18. Co-author with C. K. Sibley.

5. 1926—A Preliminary Biological Survey of the Lloyd Cornell Reservation. The Vertebrates, Bul. No. 27, Lloyd Library, Cincinnati, Ohio, pp. 71-82.

6. 1928—The Ringed-neck Pheasant, Its History and Habits. Occasional Papers No. 1, Charles R. Conner, Museum, Pullman, Washington, pp. 1-35.

7. 1928—The Hungarian Partridge in North America, and the Factors Limiting its Distribution. Northwest Science, 2:9-10.

8. 1929—The Grouse Situation in the West. American Game 18:88.

9. 1930—Propagation of Game Pheasants. (In press.)

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Pest Control Activities

(Continued from page 35)

Quarantine was being very generally violated. As a result of this revelation, the writer was ordered to make a thorough investigation of the matter by inspecting nursery shipments in transit at the large middle western terminals. Starting at St. Louis in March, 1920, a few days were spent at each of the following additional points: Kansas City, Council Bluffs, Omaha, Chicago, St. Paul and Minneapolis. During this period of about two months, over sixty violations of this one quarantine were intercepted.

This investigation very forcibly im-

pressed upon the Blister Rust Office the necessity of maintaining inspection for the enforcement of the blister rust quarantines, if these quarantines were to offer any protection to the western states. Consequently, in the spring of 1921, practically all of the personnel of the Blister Rust Office were detailed to quarantine inspection work, acting under the authority of the Federal Horticultural Board. Besides two men who were investigating points the importance of which was unknown, fifteen men were assigned during the spring and fall seasons when the bulk of nursery stock is shipped, to twelve of the larger terminals. In approximately 35 days, 45.476 shipments were inspected and 214 violations of the Blister Rust Qurantine were found, in addition to 28 reported by collobor-ators, and others. In other words, one shipment out of every 212 was found to be in violation of this quarantine. Very probably, many violations were missed, since the inspectors were men without any experience or training in this type of work and no inspection was carried on at several important points. No attention was given to violations of other Federal quarantines.

Since 1921, inspection has been maintained each year at all or some of the following points: Chicago, St. Paul, Omaha, Kansas City, Council Bluffs, New York, St. Louis, Seattle, Spokane, Portland, Denver and Ogden. Brief inspections have been made at other distribution points. Unfortunately, this small number of points means that the work is still, to a large extent, a sampling process. Gradually, the inspectors have been trained so that they are now enforcing all Federal quarantines. The following table gives a summary of the results of the work from 1920 to June 30, 1929.

TRANSIT INSPECTION FOR PERIOD 1920 TO SPRING 1929, INCLUSIVE

Calendar Year	Number of shipments inspected	Violations by Quarantines										Total violations reported by transit inspectors	*Violations per 1,000 shipments	*Per cent violations by nurserymen	Violations reported by State inspectors and other agencies
		Barberry	Corn Borer	Gypsy and Brown-tail Moth	Japanese Beetle	Satin Moth	Narcissus Bulbs	Blister Rust	Japanese and Asiatic Beetles	Asiatic Beetle	Pink Bollworm and Thurberia Weevil				
1920	5,550							66				66	11.9	89	41
1921	45.476							214				214	4.7	77	28
1922	69,562							136				136	1.9	48	12
1923	51,571							92				92	1.8	34	21
1924	64,719							99				99	1.4	31	20
1925	122,457							104				104	.9	28	11
1926	109,168							116				116	1.1	44	14
1927	241,451	2		7	55	21		275				360	1.1	54	14
Spring 1928	123,445	6		17	22	17	1	204				267		64	16
Fall 1928	47,396	2	2	1	15		210	21				251	1.3)	Fiscal	17
1929 Jan. to June incl.	459,664	8	72	22	5	11	38	138	128	4	1	427	.3)	Yr. 1929	219
Totals	1,340,459	18	74	47	97	49	249	1,465	128	4	1	2,132		43	25

*Blister Rust Quarantines Only.

These results show the work to be so valuable, that it is clear that fairly complete protection can be secured by an expansion of the program. Your attention is called especially to the period July 1, 1928 to June 30, 1929. 507,060 shipments were inspected, 87 per cent moving by parcel post, about 12 per cent by express, and about one per cent by freight. It is estimated that about 75 to 85 per cent of the total shipments passing through the transfer points were seen by transit inspectors. As a result of this inspection, 678 violations of ten quarantines were detected, or to express this in another way, for every 3,000 shipments of plants of any kind, 4 violations of some of the Federal interstate quarantines were found. Based on our experience in the West, about 80 per cent of these violations are by parcel post and 20 per cent by express. Less than one per cent are found in freight shipments. This season, about 56 per cent of the violations were made by commercial concerns and the remainder by noncommercial concerns.

It is worthy of note that violations of the Japanese Beetle Quarantine have been intercepted, originating from heavily infested territory with from two to ten pounds of dirt around the roots of the plants.

The necessity for this inspection is well illustrated by the results from enforcement of the Blister Rust Quarantine alone. In 1920, 89 per cent of the violations were by nurserymen, in 1927, 54 per cent, and in 1928, 44 per cent. It appears that we shall always have some violations by nurserymen. Non-commercial shipments will always present a problem and furnish several violations. In 1921, 214 Blister Rust violations were intercepted, as stated, among 45,476 shipments seen. In 1928, 225 were found among 170,841 shipments.

The part which transit inspection plays in preventing the spread of insect pests is that of a second line of defense. Quarantine administration divides itself naturally into four phases: (1) scouting to determine the proper location of quarantine lines; (2) internal inspection to determine freedom of shipments from infestation; (3) road station maintenance to control vehicular traffic in the restricted articles; (4) transit inspection to provide for the return or other disposal of articles which escape surveillance of the inspectors inside the infested area and would reach destination unless intercepted. The importance of transit inspection is much greater than is indicated by the number of violations discovered, for almost every such violation represents a long distance shipment from infested territory and therefore, one of an especially dangerous nature.

The first two or threee phases of qurantine administration listed are of necessity carried out by specialists in the pest concerned. The responsibility for scouting and inspeciton on account of the Gypsy Moth, for example, must be laid on those who are especially familiar with the various stages of that pest. Transit inspectors, however, do not attempt to determine infestation of the products intercepted, but to decide whether the shipment is in compliance with quarantine restrictions. They are specialists in traffic, routing and train schedules. Their place in the program is similar to that of the traffic management or shipping department

of a commercial organization. Their success depends on the tact and diplomacy with which they secure the cooperation with freight, express and postal officers and employees, and the skill they use in locating plant shipments en route.

Heretofore, transit inspection has been carried on as an incidental feature of the enforcement of certain quarantines, particularly the one on account of the white pine blister rust. Under the pending Agricultural Appropriation bill for the fiscal year 1931 which passed the House of Representatives a few days ago, however, a separate item for this purpose is included, the object being to set up a comprehensive organization of national scope, a plan which should result in greatly increased protection.

I want to close my paper with the following quotation from Dr. Marlatt, former chief of the bureau, with respect to the place of quarantine work in the field of biological science.

"The enforcement of plant quarantine for the control of plant diseases and insect pests is in a general sense experimental, i. e., a demonstration of pest control on a large scale. This field of work, therefore, should be looked upon as an important and specialized branch of applied Entomology and Pathology, rather than as something distinct and separate in nature and quality. It involves the work of hundreds of loyal, trained men, whose daily operations result in the accumulation of new and valuable information and the development of new methods of control of insect or disease spread. There is no distinct and important demarcation therefore between such quarantine work and service, and the work with regard to specific pests having relation to the farm or orchard or forests. In a large sense, therefore, quarantine officials and personnel can look upon their jobs as having the natural and honorable character of experiment and research."

Conservation of Hearing

(Continued from page 37)

bright child is equipped with the means of gaining the knowledge and training which it deserves.

When we educators, social workers, and physicians become aroused to the importance of this great conservation of hearing program and realize what it means to the future generations, and band ourselves together for the carrying forward of this work, then miracles will begin to happen in every hamlet and every city of our land and there will not be a hard of hearing child left, who will not be trained to go out and lead a happy and useful life.

Leaves millions of years old which still hold all the colors of autumn have recently been found in the newly discovered fossil leaf beds of Wheeler County, central Oregon, by Dr. Ralph Chaney, paleobotanist of the Carnegie Institution of Washington. The perfect preservation of the coloring in the leaf impressions is attributed to minerals in the matrix. Dr. Chaney found in volcanic shale an intact leaf, bearing virtually the appearance it did when it fell from a jungle tree millions of years ago. This leaf was sealed in its matrix and will be sent to the University of California at Berkeley. The plant horizon is just above the beds of the Cretaceous seas which swept over ancient Oregon, leaving an abundance of marine fossils in the Mitchell area.

Development of Blister Rust Control In the Inland Empire[1]

By Stephen N. Wyckoff
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THE advent of white pine blister rust into western North Americar has brought forward a new and difficult problem in forest protection. This problem has been met and solved in the northeastern states but entirely new conditions of terrain, weather and host plants have been faced in the West. The problem primarily centers about the protection of two great bodies of susceptible timber and reproduction, the western white pine in the Inland Empire region and sugar pine in southern Oregon and California. Because of the part played in the life history of white pine blister rust by Ribes (Currant and Gooseberry plants) the presence of the disease in any region means that white pines and Ribes cannot both continue to exist in close proximity. The association of these two types of host plants in the presence of the disease almost invariably means the virtual effacement of white pine. Since white pine is the valuable host plant the problem of protection centers about the removal of Ribes from the proximity of white pine.

White pine blister rust was introduced into western North America in 1910 and was discovered in 1921. In 1922 a program of delay, experimentation and control was instituted. The delay and experimental phases of this program have now been under way for eight years. The present spread of the rust into the white pine stands of the Inland Empire has necessitated the beginning of practical control measures. The present is therefore a most opportune time to determine the progress which has been made in experimental and investigative work. Where do we stand in our knowledge of the rust and the development of control methods?

In order to give such an accounting on an intelligent basis, the general situation and the past experimental work must be briefly reviewed. By means of a white pine type survey made by the Forest Service in District 1, and by reconnaissance surveys and experimental Ribes eradication by the Office of Blister Rust Control, certain general facts have been realized as forming the basis for a control program.

(1) The Inland Empire region contains about 3,000,000 acres of white pine type which is considered suitable for protection.

(2) Bcause of the occurrence of large numbers of highly susceptible Ribes in moist locations the narrow belt of bottom land along streams, termed "stream type," represents the most immediate danger of establishment and rapid intensification of the rust. The first and immediate objective of a control program is necessarily the eradication of Ribes from this stream type on a general scale.

1. Presented at the annual meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Wash.

(3) Because of the occurrence of numerous Ribes in close association with young trees, Ribes eradication in reproduction stands is necessarily the second objective of such a program.

(4) Because of the occurrence of relatively few Ribes and because of the length of time necessary for the rust to kill large trees most of the mature timber destined to be cut within 20 to 25 years will be sufficiently protected by the stream type eradication program.

These general considerations will to a very large extent determine the form and scale of a successful program of control and any such program which does not take them into account will either fail because its objectives are not obtained or will be economically unsound because of excessive costs. What progress has been made in the development of control methods suitable to such a program? These con also be briefly enumerated.

(1) Hand pulling methods of Ribes eradication for reproduction and mature timber stands are well developed. The cost of such operations will vary, with several uncontrollable factors, between 75 cents and $3.00 per acre.

(2) It is recognized that hand pulling in those parts of the stream type where bushes are most numerous is not feasible because of low effectiveness and excessive cost. To meet this situation the Office of Blister Rust Control has undertaken extensive experimentation upon chemical eradication. It is now recognized that this method is necessary to secure the requisite result at a practical cost. By means of combined hand and chemical eradication in the stream type, each method being used where suitable, it is estimated that this type of eradication can be done for $10.00 to $15.00 per acre on the area actually worked. It is further recognized that the stream type will constitute from 5 to 10 per cent of the forested area, thus making the prorated cost of such work vary from 50 cents to $1.50 per acre for the entire area to which this type of general protection is given.

(3) We are now able to successfully eradicate *Ribes petiolare* by chemical means. *R. lacustre* and *R. inerme* possess greater resistance to chemicals. We are as yet unable to successfully eradicate these species by chemical means, and investigative work is centering upon this problem.

(4) Practical field methods of applying toxic chemicals to Ribes in the stream type are now developed but further refinements and reductions in cost are probable. Further improvements in methods and equipment will result in the decrease of cost of stream type eradication.

In light of the conditions necessarily faced in the control program and the progress thus far made in meeting these condtions, what remains of experimental and investigative work which must be done before the entire program can be undertaken?

(1) As a most important and in fact vitally necessary condition for the ultimate success of the stream type eradication program a chemical compound must be found which will

kill all three species of Ribes occurring in the stream type.

(2) Equipment for and method of application of chemical eradication must be developed to the highest possible point.

(3) We must carefully study and check over for many years areas upon which eradication has been practiced, to determine the rate and amount of Ribes re-establishment. It is assumed that re-eradication will be necessary in many places. How soon must it be done? What is the relation of per cent of efficiency of first eradication to the length of period before a second eradication is necessary? What is the relation of the cost of first eradication to the cost of the second eradication? The solution of such points is vital to the final success of the control program but can only come by constant experimentation.

(4) The possibility of forest management leading to sustained yield is now occupying the attention of foresters and lumbermen in this region. As the depletion of virgin timber stands approaches nearer, this subject will become increasingly important. In the last analysis, forest management is an artificial governing of forest conditions to induce a desired type and rate of forest growth. What will be the effect of such control of conditions upon Ribes establishment and growth To know this we should have concrete expression of these conditions and the degree to which they are altered by forest management. Has not the forester a responsibility here? Is it not incumbent upon him as the logical and proper investigator of forest conditions to determine and weigh the facts concerned in forest growth and to inform us in what way and to what extent they will be altered by forest management? And is it not our responsibility when the forester has given us this information to determine the effect of the control and alterations of these factors on Ribes growth?

(5) The action of the rust itself must be studied on the native hosts and under the natural conditions of the Inland Empire. The Office of Forest Pathology is doing splendid work in its study of the rust in British Columbia. But the opportunity is just coming to observe it under the conditions in which we must fight it. Such studies must necessarily be carried on for long periods so as to cover a wide range of seasonal weather variations.

You will no doubt agree with me that the points which I have briefly mentioned constitute a wide and necessary field of invstigation. This field must be carefully explored before the blister-rust-control program can be effectively completed. At this moment with the rust present in the Inland Empire the temptation is very great to devote all of our available energies to actual control operations, thus sacrificing the investigative work vitally necessary to the ultimate success of that very control program. Our final success or failure will be measured by our foresight in carrying to completion the study of the factors influencing our work and of the methods of getting the work done.

"A stethoscope for listening to grape fruit has solved a fruit problem. Until recently there was no way of detecting the Mediterranean fruit fly in grape fruit without cutting the fruit open, thereby spoiling it. Since worms eat fruit by tearing off morsels, they make a noise in so doing, and if this sound is amplified by thermionic tubes (like those in radio) the sound of flies eating into fruit is audible."—*The Business Week.*

Economic Status of Forest Insects In the Northern Intermountain Region[1]

By
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IN view of the very destructive season of 1929, it is perhaps more difficult than ever to visualize insects or diseases as being economic enemies of our forests. Fire is spectacular. The attention of the public is directed toward it through the publicity which is given to the closing of forests to hunting, fishing, and camping, the mobolization of men to combat the flames, the smoke which lies as a pall over our northwestern states during the summer, and the danger to and destruction of human life. The work of destructive forest insects, on the other hand, is more or less insidious in character, and unless epidemics occur, laymen, and quite often the agencies charged with the protection of the timber lands harboring the infestations, are seldom aware of the destruc_ tion which is occurring As a result of these conditions fire has received more public consideration and attention than either insects or disease. This is as it should be, for fire is, and may for some years continue to be, the greatest potential enemy of our forests. However, it is now fully recognized that if our program of forest protection is to be made complete, adequate attention must be given to insects and diseases, as well as to fire.

For some time it has been realized by many agencies charged with the protection of private and public lands that the destruction of standing timber by insect attack is of such importance as to warrant ranking it with fire in our thoughts of protection. In comparing the losses of timber caused by insect attack with those caused by fire, there is no thought of claiming that the problems of forest entomology are of more economic importance than those of fire. Regardless of their size or location, an effort is made to suppress all fires within our forests, which reduces the loss from this agency to a minimum. Insect outbreaks, however, are for the most part uncontrolled, so in reality a maximum insect loss is compared with a minimum fire loss.

A word as to the monetary importance of this phase of forest protection. In the western states bark beetles alone destroy some 5,000,000,000 board feet of mature timber annually. Defoliating insects likewise take an annual toll from our forests of some 1.000,000,000 board feet. A conservative estimate of the value of the saw timber destroyed annually by insects would be from $15,000,000 to $20,-000,000.

In these figures no consideration has been given to timber stands of high scenic value which have been destroyed by insects. It is difficult to place a monetary value upon the timber within our National Parks, watersheds, game preserves, camp sites, and other recreational areas. However, the values of such timber often outweigh those of strictly commercial forests.

Insects play another role in our plans or forest protection which at this time is of peculiar significance. Not only do insects destroy large volumes of high-grade commercial tim-

1. Presented at the annual meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Wash.

ber, but the trees which they kill create serious fire menaces, increasing the cost of fire protection, the severity of the task, and the danger of the operation. Epidemics of the mountain pine beetle in lodgepole pine cover many square miles and often destroy from 60 to 80 per cent of the trees within the infested area. In a few years these dead trees fall, creating dangerour fire traps which last for several decades. Our experience has shown that fires inevitably follow these epidemics—fires which are practically impossible to check while burning in such areas. Throughout our white pine forests the snags, which stand as monuments to the energy of the mountain pine beetle, will always be the fire fighters' mortal enemy. Sparks blown from snags have time and again undone the work of fire line construction, costing thousands of dollars, as well as destroying larger areas of forested lands. It would seem that instead of giving thought to the removal of these snags from the danger zone within the fire line, which is an expensive and dangerous operation, consideration should be directed towards the prevention of their occurrence,—the elimination of the cause rather than the effect.

To support the somewhat abstract statements which I have given relative to the economic importance of forest insects and the need for their consideration in all programs of forest protection, more concrete evidence should perhaps be submitted. To do this it is necessary that some of the more important forest insect outbreaks which confront us at this time be briefly discussed. Space will not permit a full discussion of these situations, and it is hoped their importance will not be measured by the space devoted to them.

For several years an epidemic of the mountain pine beetle in the lodgepole pine stands of Montana has been sweeping southward from the Flathead National Forest along the Continental Divide. The description of this epidemic is a somewhat difficult task, as the infestation has reached such a magnitude that its true representation is rather unbelievable. On the Bitterroot, Deerlodge, Missoula, and Beaverhead National Forests, millions of trees are being killed each year. If you could visualize mountain sides, thousands of acres in area, literally red with the dying foliage of insect-killed trees, then you would have an idea of the severity of this outbreak. For several years an attempt was made through the institution of artificial control measures to prevent the southern spread of this epidemic into valuable commercial and park timber stands which lay in its path. The Big Hole Basin, lying across the head of the infestation, was selected as a battle zone, a catch basin, in which all infested trees were to be located and treated as long as the source of supply existed. For three years this zone of defense was held, but during the summer of 1928 the flight of insects which poured into the area from the heavy blocks of infestation to the north made the continuation of the project an unsound procedure. In the spring of 1928 some $95,000 were spent in cleaning up a large proportion of the infested forest within this zone of defense. As a result of this heavy influx of beetles into the area, at least $400,000 would have been required to cover the same tracts in 1929 as were treated in 1928 for $95,000. Furthermore, this expenditure would not have written the final chapter to the story, for plenty of evidence existed to indicate that in 1930 at least $1,500,000 would have been required for the same area, with prospects of even larger expenditures in the next few years. In the face of these conditions there seemed to be no other course to follow than to discon-

tinue the Big Hole Basin plan of control. Data secured from a survey of this area during the late summer of 1929 clearly demonstrated that the decision in this matter was correct. Though the Big Hole Basin project was abondoned in 1928, there has been no cessation in the efforts of the Forest Service and Bureau of Entomology to prevent the further spread of this epidemic into the more valuable timber stands previously mentioned. Advantage is being taken of the rather wide timberless tract of land which lies between the Beaverhead and Madison National Forests in the hope that it will at least act as a partial barrier to the spread of the insects. A careful check will be maintained of the timber stands to the south of this barrier and all infested trees will be promptly treated.

In the lodgepole pine stands of central Idaho a similar epidemic of the mountain pine beetle has developed during the last few years. Though not of such magnitude as the Montana epidemic just described, it is a serious situation and hundreds of thousands of trees are being destroyed annually, with prospects of heavier losses in the future.

Within the forests immediately to the south of the Yellowstone National Park a serious outbreak of the same insect, again in lodgepole pine, has been developing for the last three years. Every possible effort is being made to check this outbreak, for in the event of its spread the destruction of adjacent commercial and park timber stands is almost certain. Control measures were first instituted in 1928 and again in 1929, and will be continued during the coming season. Last spring some 40,000 trees were treated, but as the infestation was far more severe and widespread than had been anticipated the available funds were sufficient to secure a complete clean-up of all the infested tracts. Not more than 20 per cent of the infestation within these tracts was left untreated, but from this a sufficient number of insects emerged during the summer to attack and destroy practically the same number of trees as were treated during the spring. Though these data may seem to indicate that control measures had little affect in reducing the number of insects within the region, and that the project was a failure, such a conclusion would be an incorrect one. A rapidly increasing infestation is being combated, and it is quite certain that if no control measures had been instituted in 1929 there would have been at least 150,000 trees to treat in 1930 instead of only 40,000.

In the white pine stands of northern Idaho and western Montana there is always more or less loss of timber due to the attacks of the mountain pine beetle During the last few years this loss has been rather steadily increasing so that in many areas serious situations now exist. Within the Coeur-d'Alene, Kaniksu, Pend Oreille, and Kootenai National Forests, outbreaks of this insect are rapidly becoming widespread A conservative estimate of the loss of white pine caused by the attacks of the mountain pine beetle during the season of 1929 would not be less than 75,000,000 board feet. On the Kootenai National Forest control measures have been used for the past two seasons in an effort to check the destruction of timber. On the Coeur d'Alene National Forest control measures were instituted on one small area in the spring of 1929. During the season it has been found that this infestation extends over practically the entire forest, and that $150,000 will be required for control during the coming season. On the other forests mentioned the infestation has reached such a magnitude, and such a large proportion of the stand has already been destroyed, that control measures are considered inadvisable.

In passing from the depredations of bark beetles a word must be said relative to the importance of those insects which feed upon the foliage of forest trees.

The spruce budworm, an insect which a few years ago destroyed, within the forests of Maine and adjacent Canadian provinces, a volume of pulpwood sufficient to supply the needs of the United States for a quarter century, has in the past few years become recognized as a serious enemy of our western forests. In 1928 there were over 800,000 acres of timber lands infested by this insect within the National Forests of Idaho and Montana, on which a large percentage of the trees will die.

The fir tussock moth, belonging to the same family as the dreaded gipsy moth of the New England States, has recently become an important enemy of our Douglas fir forests. In Nevada, central Idaho, and northeastern Washington, large areas of Douglas fir trees are being stripped of their foliage and are already partially destroyed. Space will not permit touching upon the other defoliating problems with which we are confronted at this time.

Though only the so-called high lights of the economic status of forest insects have been mentioned, and the other economic problems of forest entomology which must be considered in our forestry programs have been passed over, it is believed that the picture as drawn is sufficient to demonstrate clearly the economic importance of forest insects. Within the pine forests of Idaho and Montana there exists the most serious forest insect situation we have ever experienced, or of which we have any record Not only are tremendous volumes of high-grade commercial timber being destroyed each year, but hazardous conditions are being created within the forests which will inevitably court the presence of fire—completing the destruction started by insects.

The situation as described is not a pleasant one to contemplate. The many problems which make up this condition are proving to be difficult ones to solve. However, no matter how difficult and discouraging they may appear at this time, a solution can and will be found. Intensive research, delving into the fundamentals of such problems, must be conducted. Not only is such research necessary, but all agencies charged with the protection of timber lands must be brought to realize the seriousness of the problem, and the need for prompt and thorough action if future losses of timber from insect attack are to be prevented. The combating of insect epidemics is a laborious, expensive, and sometimes very uncertain procedure. Such epidemics can only be prevented by regarding all infested trees as being, potentially, the starting points for outbreaks. Provision must be made for the prompt location and treatment of these trees, if losses under endemic or normal conditions are to be reduced to a minimum, and epidemics prevented. Such concentrated action for the protection of timber from insect attack may appear to be an expensive procedure, but I am sure that over a period of years it will prove to be more economical than the combating of epidemics, and will not only result in a greater saving of timber, but will materially reduce the cost of fire suppression.

Rhythmic Corrugations In Highways[1]

By
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IN places where hard surface roads for one reason or another cannot be built, and traffic warrants an improved road, it has been customary to surface the road with gravel or crushed rock with which a small amount of clay is mixed for binder. There are thousands of miles of such highway in use throughout the United States with many additional miles being added each year.

A crushed rock, or gravel type surface when in good condition gives excellent service for both passenger and trucking traffic However, as the volume of traffic reaches one thousand or more cars per day, such a surface quickly develops transverse corrugations which are commonly called "washboards." Thse are also known as rhythmic corrugations, ripples, chatter bumps, etc.

The presence of "washboards" in gravel or crushed rock highways has proven to be a serious problem in many ways. For one thing, it increases the hazard of driving in that cars cannot be so well controled over such highways at high speeds. The severe treatment endured by the tires and running gear of the car tend to shorten the life of those parts materially. In the case of trucks, a badly "washboarded" highway tends to limit the maximum possible load which the truck's springs can carry. On account of these problems, the highway maintenance engineers have continuously sought means whereby they could either eliminate or materially diminish the formation of "washboards" in gravel highways. Their efforts have been directed primarily toward the treatment of the road surface, and this has been only partly successful. By the use of intensive maintenance such as frequent planing and blading of the gravel surface, they have found it possible to limit the depth of "washboards" on such highways. However, the fact that, in order to plane down the "washboards," the road surface is being continuously stirred and pulverized by the maintenance equipment has augmented what has commonly been called the "dust menace" of driving and has resulted in a rapid loss of binding material carried away by the wind. For these reasons and in the interest of economy it is desirable if possible to learn if there might not be some better way of minimizing the "washboard" menace than by means of an intensive maintenance program.

With this situation in mind, the Engineering Experiment Station of the State College of Washington a number of years ago undertook a study of the cause and prevention of "washboards" in gravel highways. In 1926, a car was equipped with a recording mechanism which recorded on

1. Presented at the annual meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Wash.

paper the relative motion of a car axle with respect to the body of the same car when traveling over "washboarded" roads Extensive tests were made at different speeds over several different "washboarded" highways. Tests were also conducted on perfectly smooth roads on which had been placed a bump or a single depression. This made it possible to analyze the entire history of a single road shock.

During the summer of 1927, a small laboratory apparatus was developed which embodied the characteristics of a car and on which tests could be made without the introduction of disturbing influences other than those being studied. All cars possess the characteristics of sprung and unsprung weight. The car body, which is carried on the springs is the "sprung weight." The car axle together with the hubs, brakes, and wheels constitute the "unsprung weight." This "unsprung weight" however, is somewhat cushioned by the air in the tires. By means of the above mentioned laboratory apparatus, careful analysis was made of the relative motion of the different parts of the car when subjected to "washboard" shocks at different speeds. The results of these tests were published in Engineering Bulletin No. 19.

In order to further study this problem, during the following summer of 1928, a test track was built on the State College campus for carrying on further "washboard" tests. This circular track was built 175 feet in diameter and banked for a normal speed of twenty miles per hour. The surface of the track was given a gravel topping according to standard highway specifications except that it was only about 5 inches thick. A model T Ford touring car, used for the test, was equipped with high pressure tires, namely, three and one-half inch tires at fifty-five pounds air pressure and driven at twenty miles per hour. "Washboards" could be formd on the gravel surface of the test track in 100 trips. Equipped with hydraulic shock absorbers, the formation of "washboards" was found to be much slower. In fact, it was not possible to make satisfactory "washboards" on the test track with this combination. When balloon tires were substituted, without shock absorbers, it was found impossible to make "washboards" on the test track, even though the test was continued until the road was virtually worn out.

While the above tests all contributed to the fund of information on the subject of "washboards," it was felt that further tests should be conducted on a straight highway. This would more nearly duplicate the conditions which exist on the public highways, and results from such tests would be more readily accepted by engineers and others interested in highway maintenance.

The results of the foregoing tests and experiments would seem to indicate that there is a possibility of solving the "washboard" problem, in so far as it can be solved, not by attacking it from a maintenance standpoint but by controlling the conditions and characteristics inherent in the car itself. If this were possible, then at least part of the present objectionable and expensive method of continuously

loosening the road surface would be eliminated. A reduction of this present maintenance program would save substantial amounts of maintenance money, which otherwise could be devoted to improving the highways. With these things in mind, the problem was laid before the State Highway Department of Washington. Later, with their cooperation, a stretch of gravel road was chosen and prepared for further tests during the summer of 1929.

Out of several sites under consideration, one was chosen which is located about twelve miles southwest of Spokane. More particularly, this road was a part of the original highway between Spokane and Cheney before the new concrete road was built. It runs east and west on the east side of the concrete highway and one-fourth mile north of Four Lakes, Washington. The road is level throughout its length except for a short section which has a grade of from three to four per cent. During the season of the spring rains, the State Highway Department went over this road with a grader and left it perfectly smooth. Under the normal light traffic (ten to fifteen cars per day), the surface became hard and smooth. During the following dry weather, a grader was again used to plane the surface leaving about two inches of loose material on a perfectly smooth hard base. The test road which was one and four-tenths miles long was divided into five sections. On the section at one end of the road a speed of twenty-five miles per hour was maintained in either direction. On the adjacent section, the speed was raised to, and maintained at, thirty-five miles per hour. On the next section, at forty miles per hour; on the next section, at thirty miles per hour; and on the other end section, twenty-five miles per hour. At each end of the track, a short section was reserved for decelerating prior to turning around and for accelerating again to twenty-five miles per hour. Also between sections, it was necessary to reserve a short distance for accelerating or decelerating for the speed in the next section. Thus, when the test was completed comparative results were shown at four different speeds.

The driver of the test car was constantly on the alert during the progress of the test to observe the first appearance and location of "washboards." Note was made of the time of occurence and the section of the road on which "washboards" first appeared. As might be predicted, "washboards" first appeared on the highest speed section. Furthermore, it was observed that the average length of "washboards" varied according to the speed of travel on that section.

From these tests it was learned that speed of travel bears a definite relation to the rapidity with which "washboards" are formed by high pressure tires. It was also noted during these tests that the average length of "washboards" in the different speed-sections varies somewhat according to the speed of travel of the car used in the tests, and this is to be expected. Furthermore, the addition of one type of shock absorber at least has a retarding effect on the formation of "washboards" and would seem to prevent

their formation at low speeds. It was noted in these tests, that balloon tires did not make "washboards" even after prolonged operation on the test track. Whether or not, balloon tires would promote or retard their formation on an already deeply "washboarded" highway is a question yet to be answered. Likewise, the comparative effectiveness of the different types of snubbers and shock absorbers is still to be determined.

Briefly, the results of the 1929 tests were as follows:

The test car, equipped with high pressure tires, namely 30x3½ inch tires at 55 lbs. air pressure, and driven at 40 M.P.H., made visible "washboards" in 50 trips, (or in 25 round trips) over the test road.

At 25 M.P.H., "washboards" appeared after 120 trips.

When four two-way shock absorbers were applied to the test car and the tests were repeated, at 40 M.H.P., "washboards" appeared after 110 trips. You will note it took more than twice as much traffic to make "washboards" with these shock absorbers than without them.

At 30 M.P.H., the same relationship was true, that is, it took twice as much traffic to make "washboards." However, at 25 M.P.H., no "washboards" appeared during any of the tests with shock absorbers.

When balloon tires were substituted for the high pressure tires, namely, size 4.40 at 34 lbs. pressure, and the tests were repeated with the same test car, no "washboards" could be made on the test track either with or without shock absorbers even after more than 500 trips.

As mentioned above, the average length of "washboards" was found to vary on the different speed sections of the test track. For instance on the 25 M.P.H. section, the average length of "washboards" was found to be 22 inches, while at 40 M.P.H. they averaged 29.4 inches. It will be interesting to note that the average length of "washboards" measured on other highways in eastern Washington at this time was found to be from 28 to 29 inches."

In conclusion we would point out that the tests thus far indicate that the balloon equipped car does not possess propensities for starting "washboards" in gravel highways, but that high pressure tires especially when driven at high speeds, have very definite tendencies to make "washboards."

While the percentage of high pressure tires on passenger cars has greatly diminished and is at present very small, the percentage of trucks on the highway is constantly increasing. Truck tires are, at present, essentially of the high pressure type, although a very few trucks are using what is known as the truck type balloon. Most truck tires are operated at approximately 100 pounds air pressure which, together with heavy loads and relatively high speds, would cause a more violent reaction upon the road surface than in the case of the above tests with 55 lb. tires. It is hoped that subsequent tests in the laboratory and on the highway will yield definite information as to how much the behavior of the car or truck wheel can be controlled with reference to its propensity for making "washboards." We have found much evidence showing that snubbers or shock absorbers applied to the high pressure type of tires will not only contribute to the easier riding quality of the vehicle thus equipped, but will serve to diminish the expense of maintenance both of the road and of the car. Such an

accomplishment would point the way to a possible saving in maintenance money in the State of Washington alone of many thousands of dollars per year.

It is expected that these studies will be continued at the State College so long as information can be gained which will be of use in bettering the highways and in reducing the cost of maintenance.

A complete and well illustrated report of the 1929 tests is published in Engineering Bulletin No. 31, copy of which may be had free for the asking. Write to the State College of Washington, Pullman, Washington, and ask for the *Washboard Bulletin.*

THE CELLULOSE CROP

"Maybe we shall soon be talking about the Cellulose crop. There are premonitory stirrings in the ranks of lumbermen suggestive of another one of those industrial 'revolutions' that are turning the world into a merry-go-round. The chemical engineer is now saying to the lumberman: Take a big crop of small trees every ten to fifteen years instead of a small crop of big trees every hundred years—not of lumber, but of wood, cellulose. One responsive forester already visions gigantic mowing machines, drawn by supertractors, crunching through dense fields of young trees, even as the combine now cruises gaily across the wheat fields of Kansas. From the forest the wood goes to converters, comes out as cellulose—and, presently, the cellulose is made into 4000 commodities, everything from candy wrappers to synthetic lumber. Nothing is wasted, tree growing becomes profitably feasible; and the forest, capable of perpetual production, will relieve in many ways the pressure on the minerals which, once mined, are gone forever."—*The Magazine of Wall Street.*

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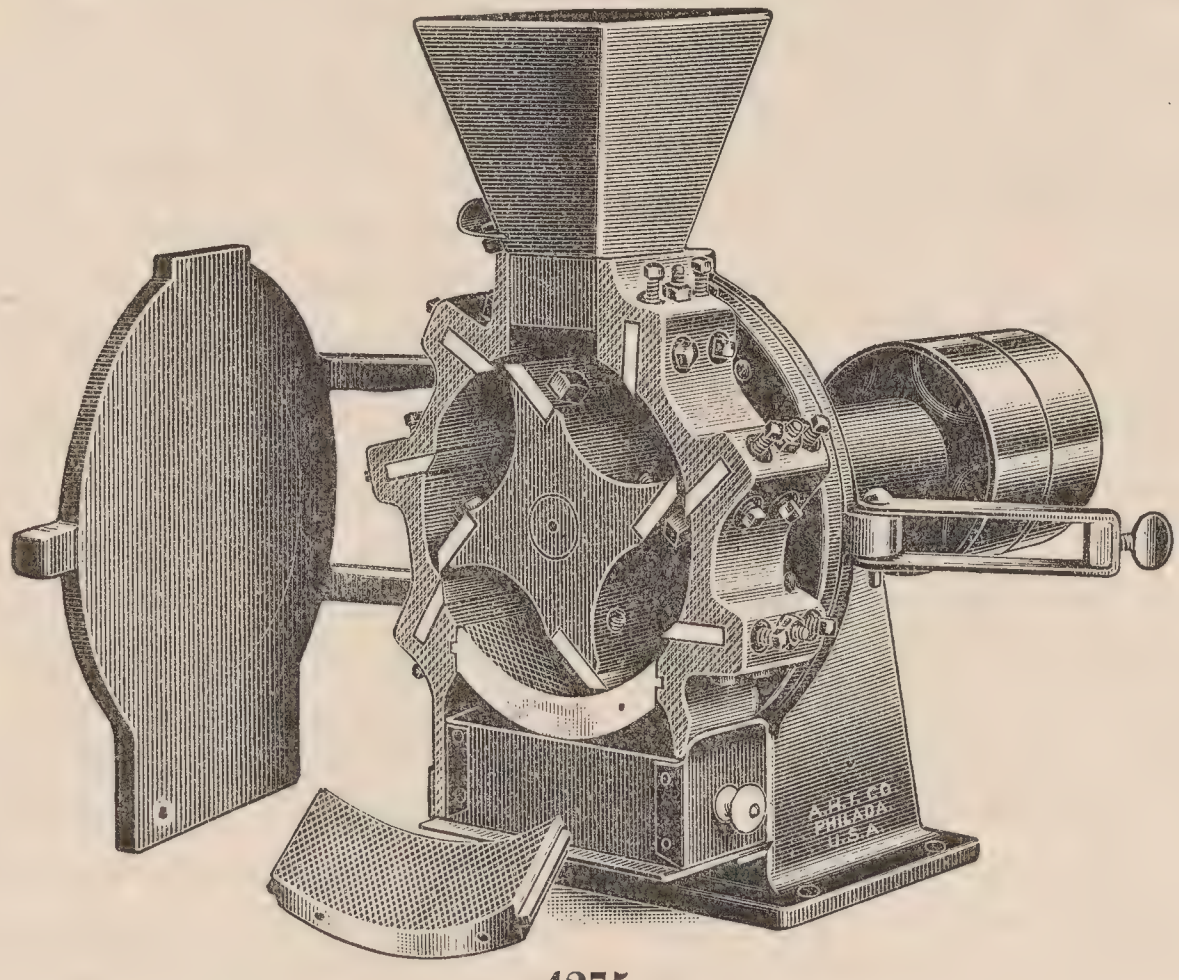

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LABORATORY MILL, Wiley (Patented). Four knives on a revolving shaft work with a shearing action against six which are set in the frame. The screen is dovetailed into this frame so that none of the material comes out of the grinding chamber until it is fine enough to pass through the mesh. Three sieves with screen of ½ mm, 1 mm and 2 mm mesh, respectively, are furnished with each mill. A hinged front permits easy cleaning.

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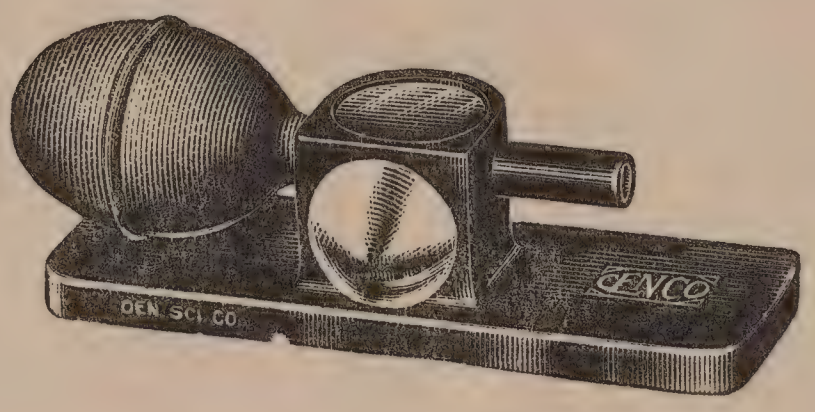

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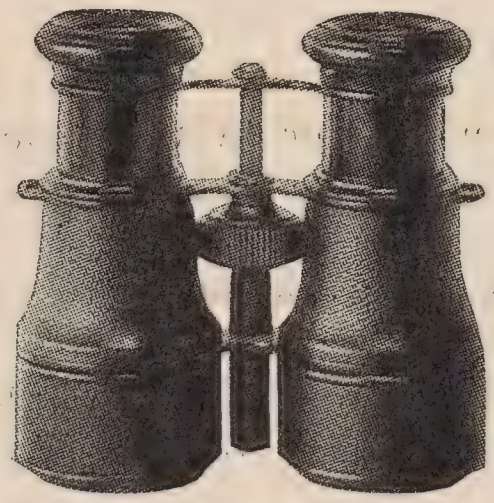

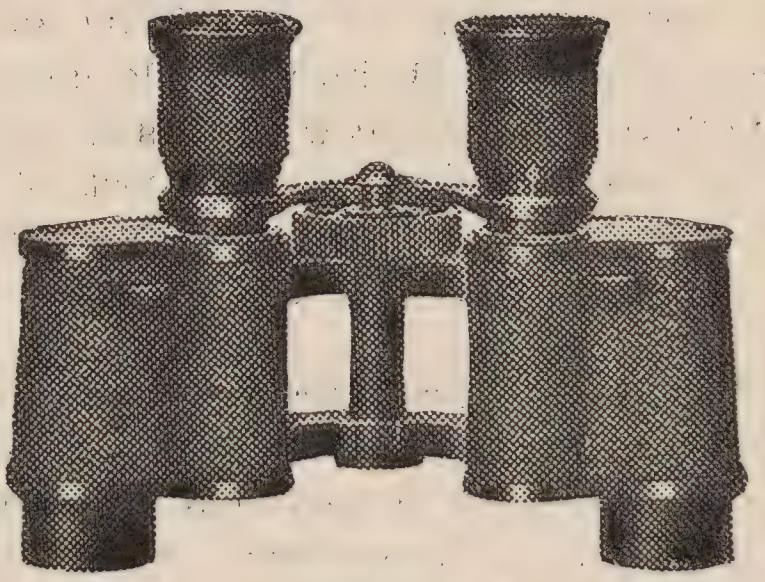

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EDITORIAL

Research in Our Educational Institutions

SOMEONE carrying out an alphabetical research problem has concluded "that the letter 'e' is the most unfortunate letter in the alphabet, because it is always out of cash, forever in debt, never out of danger, and in hell all the time. No little credit is due, however, in that it is never in war, and always in peace. And we are deeply indebted to this little letter since it is the beginning of existence, the commencement of ease, and the end of trouble. Without it there would be no meat, no life, and no heaven. It is the center of honesty, and although it starts off in error, it ends in making love perfect."

The investigator might have added that this frequently used letter is also the head of education, the headlight of enlightenment and does double duty in research. The letter "e" thus serves as an important integral of our language and can hardly be dispensed with.

Research bears a similar relation to many of our activities in that it is indispensable, and, in the field of education it forms the catalyzer which brings the educational elements into a perfect compound. There is not space to discuss the values of research in education but little is needed since most educators recognize its stimulating contacts. The greatest deterrant to the development of research in educational institutions is the lack of time essential to the pursuit of investigative problems, and time must somehow be found. Another academic year is approaching and an appeal is made to all members of the Association and to those interested in science and scientific research to bend every effort toward the stimulation of interest and participation in the various problems of research calling for solution in the Pacific Northwest. The educational institutions are charged with the task of enlightenment; it is therefore their unswerving duty and the duty of each instructor insofar as he may, to furnish new oil for the lamp.

As a result of extensive negotiations with Mr. J. Murray Luck, Secretary of the Pacific Division and the invitations extended by the Spokane Chamber of Commerce, President Holland of Washington State College and members of the Northwest Scientific Association it begins to appear as if the 1932 meeting of the Division might be held in the Inland Empire. Encouraging support has been volunteered by the various educational institutions, the commercial organizations and others. It is obvious that such a meeting is highly desirable and will do much to stimulate interest in science within the Northwest region. Such a meeting will make it easy for the University of Montana and other neighboring institutions to participate to the fullest exent. It is hoped that the members of the Northwest Scientific Association will interest themselves in this commendable movement and help to bring the meeting to the Inland Empire in 1932.

Jason Lee's Part In the Founding of the Commonwealth of Oregon

By C. J. Brosnan

Department of American History, University of Idaho.

Jason Lee, the pioneer Methodist missionary of Oregon, came from an ancestry prominent in the annals of New England, although he happened to be born in Stanstead, Lower Canada, then considered a part of Vermont. In order to fit himself for service in the Methodist Church, he entered Wilbraham Academy, Wilbraham, Massachusetts, the leading Methodist school in New England, whose principal, Dr. Wilbur Fisk, was later instrumental in securing Lee's appointment to the Flathead Mission in the northwest.

Lee journeyed overland to Oregon, arriving at Fort Vancouver in September, 1834. For four years he and his associates labored at the hopeless task of christianizing and educating the Indians, who were but a diseased and degraded remant of these native races.

As early as 1837 Jason Lee had come to the conclusion that the work of the Willamette Valley Mission was a failure so far as the Indians were concerned. An epidemic in the year 1829 had swept thousands of them away.[1] During the next eight years from 1829 to 1837, their already thinned ranks were further reduced by disease. Influenza was a particularly fatal affliction, and worked havoc among them.[2] It is thought by several careful writers that Slacum's visit in January, 1837, was influential in deepening Lee's conviction that he ought to change the missionary emphasis from a program of conversion of Indians to the upbuilding of an agricultural settlement.[3] This conviction was but one of several reasons for Lee's desire to go East in person. It was a time when the growing interest in Oregon was intensified by the renewal of the Convention of 1827, as the ten-year period of joint-occupancy expired in 1837. Furthermore, because of the great distance that lay between the Willamette Valley and the office of his mission board in New York City, it seemed almost impossible for him to present effectively, by correspondence, the needs of his mission. He needed to hold personal conferences with the board of managers of his Missionary Society.[4] Mr. Lee also realized that if he were present in the East he could aid the Board in raising funds for the Oregon Mission, through his personal appeals to eastern missionary audiences.[5]

Lee's plan of making the long journey in person met with the unanimous approval of his mission colleagues. Ten days before his departure a number of settlers met at the mission station and drew up a memorial which Lee was asked to present to the Congress of the United States. This memorial was drafted by P. L. Edwards and was signed by J. L. Whitcomb and thirty others, on March 16, 1838.[6]

Ten days later, on March 26, 1838, with two Indian boys, Thomas Adams and William Brooks, and Philip L. Edwards, Lee descended the Wilamette River by canoe. He made a short

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[1]Clark, Down and Blue, A History of Oregon, 20-21.

[2]Charles H. Carey, *History of Oregon* (Portland, 1922), 410.

[3]Bancroft, *History of Oregon,* I, 166.

[4]Bancroft, *History of Oregon,* I, 166.

[5]Oregon Mission Record Book entry for March 26, 1838, *Oregon Historical Quarterly,* XXIII, 259.

[6]P. L. Edwards, Sketch of Oregon MS. (Bancroft Library).

six-day visit at Fort Vancouver, but contrary to many reports, he was not greeted by his generous friend, Dr. McLoughlin. The big-hearted host of Fort Vancouver was then absent on an extended visit to England. At Vancouver, the Lee party was joined by Mr. F. Y. Ewing, a well-known citizen of Missouri, who was in Oregon for his health. By another canoe voyage Lee ascended the Columbia River, reaching the Dalles Mission on April 7. Here he made a brief two-day visit at the recently erected mission station, which was in charge of his nephew, Daniel Lee, and H. K. W. Perkins. On Sunday, April 8, Lee addressed "more than a hundred" Indians in the Chinook jargon. The next day, after an affectionate parting with his nephew, Lee resumed his eastward journey.[7] At Fort Walla Walla he employed Indian guides and continued his travel from this point on horseback. On April 14 he reached the Whitman mission at Waiilatpu, where he enjoyed the hospitality of Dr. and Mrs. Whitman until April 17.[8] During his stay he was an interested observer of all the operations connected with their new missionary enterprises.[9] Discovering at this point that the fur brigade which was to escort him across the "Snake Country" would not be able to depart immediately, Lee occupied his time profitably by continuing onward from Waillatpu to Lapwai. At the Lapwai Mission, near the modern Lewiston, Idaho, he was the guest of the Rev. H. H. Spalding from April 18 to April 23. Here again he was an interested spectator and made careful observation of the endeavors made by the Spaldings to convert the Nez Perce Indians.

Returning again to the Whitman mission for a short visit on May 2, Lee started on his long Oregon Trail journey on May 12. Before leaving this area, Jason Lee wrote Daniel Lee a revealing personal letter. In this note, which gives a frank and unguarded account of his observations at the Whitman and Spalding stations, it is very clear that Jason Lee, as early as 1838, entertained no illusions with reference to the probability of elevating the Red Men of the Far West.

Proceeding southeastward from the Whitman mission, on May 12 Jason Lee joined the Hudson's Bay fur brigade bound for Fort Hall. He now pressed through the Blue Mountains past Fort Boise, reaching Fort Hall on June 16. Near this point the three sons of Thomas McKay were intrusted by their father to Lee's care. Lee was to place these wide-awake, half-breed lads in school in the East.[10] On horseback they set out from Fort Hall on June 29 for the American Rendezvous, which, in the year 1838, met on an island in the Po Po Agie River, a southern branch of the Bighorn River in central Wyoming. After camping here for one week,[11] Lee went on toward St. Louis with an American Fur Company caravan. After a successful trip of fifty-two days from Rendezvous, he reached the Shawnee mission near the Missouri frontier. Here Lee and his Indian boys tarried for a few days under the hospitable roof of Rev. Thomas Johnson, superintendent of the Shawnee Mission Station. While resting here, Lee received at one o'clock in the morning of September 8, 1838, the news of his wife's death in Oregon on the preceding June 26. This information was brought to him by two Hudson's Bay Company messengers sent from Fort Hall.[12]

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[7]Christian Advocate and Journal, XIII, 60. (Nov. 30, 1838).

[8] Jason Lee's Diary, *Oregon Historical Quarterly,* XVII, 417.

[9]Mrs. Marcus Whitman Letter, *Oregon Pioneer Association Transactions,* for 1891, 105.

[10]C H. Carey, *History of Oregon,* 356.

[11] Journal of Myra F. Eells, *Trans. Ore. Pioneer Assoc.,* 1889, 79, 80.

[12]*Peoria Register and North Western Gazetteer,* reproduced in *Christian Advocate and Journal,* XIII, 49 (Nov. 16, 1838).

Resuming his eastward journey through Missouri, Lee and his five Indian boys embarked at Westport, five miles east of the Shawnee Mission, for a canoe voyage down the Missouri River. Descending this stream at the rate of about fifty miles a day, Lee reached the "sylvan" city of Alton, Illinois, on Saturday, September 22. Here he found the Illinois Conference in session. Unannounced, he entered the Conference with his five Indian boys marching behind him. He was cordially welcomed as a guest by the presiding officer, Bishop Joshua Soule. On the evening or his arrival he was asked to hold a missionary meeting in the Baptist Church. A feature of this service was the singing of a hymn by the Indian boys. Lee gave an interesting account of his colorful career as Missionary to Oregon. Three days before Lee's arrival the conference had taken an unusually large missionary collection. After Lee's stirring appeal, however, an additional sum of $50 was contributed to the Oregon Mission.[13]

Without doubt cherishing vivid memories of his visit at Alton four years earlier, Lee went on to the neighboring city of St. Louis. On Sunday evening, September 23, accompanied by his five Indians, Lee addressed a large congregation in the St. Louis Methodist Church.[14] The next morning he directed his journey in a northeasterly direction toward Chicago. En route, he stopped for a second short visit at Alton on September 24. At twilight on the next day he reached Carlinville. Lee records that, while having tea here, he was importuned to address the crowd which had assembled outside the tavern where he was stopping. He held a successful meeting and entertainingly explains why the offering at this point was not larger. A few days before his arrival the townspeople had made a liberal donation to supply a horse to a preacher, who returning from the Illinois conference, had lost his animal at Carlinville.[15]

On September 26 Lee held a meeting at Springfield and then went on to Jacksonville, thirty-four miles distant. Although Lee's visit at this point was brief, his Jacksonville sojourn was fruitful of historic consequences. Here the Rev. John P. Richmond was pastor of the local Methodist Church. Lee succeeded in interesting Dr. Richmond and his family in Oregon, and in the *Christian Advocate and Journal* of August 16, 1839, we find the announcement of Richmond's acceptance as one of the five ministers who were to be *Lausanne* passengers in October, 1839. In June, 1840, Lee assigned Dr. Richmond to the important mission station at Nisqually, where that missionary and his family remained until he left Oregon on September 1, 1842.[16]

Leaving Jacksonville, Lee arrived at Peoria, Illinois, on Saturday, September 29, 1838. On the following day he delivered an address at the Main Street Presbyterian Church. On this occasion he presented a graphic picture of the Oregon missionary enterprise from its inception down to 1838. A full report of this address is found in the *Peoria Register and North Western Gazetteer*. Lee's lecture on Oregon, coming as it did from a citizen who had been a resident of that far-off region for four years, created a widespread interest in the Oregon country. The *Peoria Register* account was reproduced in the *Christian Advocate and Journal* of November 16, 1838.

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[13]*Zion's Herald,* IX, 167 (Oct. 17, 1838); *Christian Advocate and Journal,* XIII, 66 (Dec. 14, 1838).

[14]*St. Louis Gazette,* reproduced in *Zion's Herald,* IX. 190. (Nov. 28, 1838).

[15]*Christian Advocate and Journal,* IX, 167. (Dec. 14, 1838).

[16]Letter from Dr John Richmond's son, Francis Richmond, quoted in Rev. Albert Atwood, *The Conquerors,* 134, 135.

Because of the illness of one of his Indian boys, Thomas Adams, Lee was detained at Peoria until Thursday, October 3. Adams remained at Peoria until the spring of 1839 when he rejoined his patron, Jason Lee, and returned to Oregon on the *Lausanne* in the autumn of that year. Thomas Adams' accidental stay in Peoria stimulated an interest, already deep, in Oregon. The flat-headed Indian boy from the distant Willamette was the object of much curiosity and he was interviewed by many persons concerning the economic opportunities of his home land. Young Adams, proud of the sensation he created, never tired of describing the superior features of the beautiful Oregon region. His colorful descriptions of the royal Chinook salmon, reniforced with boyish gestures, were listened to with absorbing interest by the adventurous young men of Peoria. To a greater extent than he could ever have realized, the Indian lad was a factor in stimulating an Oregon immigration from the Peoria region. Young Adams, or "Indian Tom," as he was called, frequented Holman's wagon and cooper shop. His friendly visits here were productive of important events in Oregon's history. Holman later testified to the fact that an influential factor in his decision to go to Oregon with the Peoria party in May, 1839, was Indian Tom's vivid description of Oregon.[17]

Thomas Jefferson Farnham, another enterprising young citizen of Peoria at the time of Jason Lee's lecture there, became the leader of a small party of nineteen men, who made a venturesome overland expedition to Oregon in the spring of 1839. A prominent member of this party was Joseph Holman. In colorful array the little band, just before their departure, drew up before the Peoria Courthouse, where a prayer was offered for a safe journey. Joseph Holman and seven other members of this little company eventually reached the Willamette Valley.[18]

After his departure from Peoria, Jason Lee and the four Indian lads proceeded northward toward the village of Chicago. This is Lee's brief reference to his Chicago visit: "Oct. 8.—Had an interesting time at Chicago. Collection, $40.35."[19]

From Chicago Lee traveled to New York State "by way of the lakes." At Detroit his boat stopped for a few hours on Sunday, October 21. Although his address here was an entirely impromptu affair, he found his audience attentive and generous.[20] One week later Lee arrived at Utica, New York. Here his company of Indian boys was reduced to three. At the nearby town of Fairfield, William C. McKay was enrolled in a medical school situated there.

Lee, with William Brooks, the Chinook Indian boy, and the two remaining McKay boys, John T. and Alexander, pushed forward toward his destination. On October 31, 1838, after a journey of seven months, he arrived safely in New York City.[21]

Lee's first problem after reaching New York City was to present his mission needs to the Board of Managers of the Missionary Society of the Methodist Church.[22] This he did at a special meeting held November 14, 1838.[23] That Lee was successful in his efforts is attested by the Board's action. On December 5 the Mission Board decided to vote the unprecedented appropriation of $42,000 for

[17]S. A. Clarke, *Pioneer Days in Oregon History,* (Portland, 1905), II, 442; Trans. Ore. Pioneer Assoc., 1896, 93; Joseph Holman, The Peoria Party for Oregon in 1839, MS. (Bancroft Library), 1, 2.

[18]T. J. Farnham, *Travels in the Western Prairies,* reprinted in R. G. Thwaites, *Early Eastern Travels,* XXIX, 10. 11.

[19]*Zion's Herald,* IX, 202. (Dec. 19, 1838).

[20]*Zion's Herald,* IX, 202. (Dec. 19, 1838).

[21]*Christian Advocate and Journal,* XIII, 46 (Nov. 9. 1838).

[22]Atwood, A., *The Conquerors,* 68.

[23]*Christian Advocate and Journal,* XIII, 54, (Nov. 23, 1838).

the Oregon Mission. This extnsive program was to include the addition of a number of ecclesiastical and lay helpers. Provision was made for five ministers, one physician, four women teachers, and a stewardess. The group of lay assistants was to include a mission steward or business agent, two carpenters, and a cabinet maker, a blacksmith, and two farmers. The Board also voted a generous amount for farm machinery, equipment for the construction of mills, garden seeds, and an appropriation of $5,000 for merchandise.[24]

In early December the Board requested Jason Lee to assist in a campaign to raise funds for the Oregon Mission. So successful was Lee in these appeals that during the six months' period from December, 1838, to June, 1839, his stay in the East consisted of an almost continuous succession of missionary meetings. He conducted three extended missionary tours. In his first, or Southern tour, he spoke in twelve cities and towns in the vicinity of Philadelphia and Washington, D. C. His second campaign included speaking engagements through New England, northward from Connecticut to Canada. On this expedition Lee held thirty meetings. His farewell tour included a series of day - by - day speaking engagements through nineteen cities and towns of the state of New York.

Before beginning his Southern tour, Lee filled a number of speaking engagements in New York City and in its vicinity. The presence of Lee and his Indian wards in New York City churches drew crowded audiences in early November.[25] The opening engagement of Lee's southern tour was at Philadelphia. Here a successful meeting was held on the evening of December 4, 1838. This occasion was signalized by an address by Lieutenant W. A. Slacum, who will be remembered as the official visitor from the Federal government to Oregon. In his carefully prepared address Slacum spoke of Lee's missionary work in terms of unreserved approval. Another unusual feature of the Philadelphia meeting was the speech of William Brooks, the Chinook Indian boy. Brooks' fervent plea for the financial support of the distant mission station where he had so recently received instruction, was listened to with deep interest. His remarks were translated to the audience by his patron, Jason Lee. The collection, $512.26, taken at the close of this meeting was the largest donated by any gathering during the eastern tour.[26]

At Washington, D.C., the meetings were enthusiastic and well attended. His first engagement was at Wesley Chapel on Tuesday evening, December 18, 1838. Dr. Thomas Sewall, Jr., son of the venerable chairman of the occasion, referred affectionately to Jason Lee as a former Wilbraham Academy roommate. The amount donated and subscribed at this meeting reached the generous total of $399.95.[27] Lee's second Washington meeting was held on December 31. Two members of Congress, Representatives P. G. Goode and C. Morris, were speakers on this occasion. Adding a touch of color to this event was the speech of William Brooks. It was at this meeting that the young Chinook boy attempted his first speech in English. With deep emotion he delivered his appeal in expressive but somewhat ambiguous English. "His tears spoke with resistless eloquence," is the phrase used by an observer at this meeting.[28]

It was while Lee was meeting his

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[24]Bancroft, *History of Oregon,* I, 171.

[25]New York *Spectator,* reproduced in Zion's Herald, IX, 190 (Nov. 28, 1838); *Christian Advocate and Journal,* XIII, 50,(Nov. 16, 1838).

[26]*Christian Advocate and Journal,* Jan. 4, 1839, XIII, 77.

[27]*Christian Advocate and Journal,* XIII, 85 (Jan. 18, 1839).

[28]*Ibid.,* XIII,, 102 (Feb. 15, 1839).

missionary appointments at the Federal capital that he presented Oregon's second Memorial to Senator Linn. On the following January 26, 1839, Senator Linn presented to the United States Senate this well-phrased document signed by the thirty-one ambitious Willamette Valley pioneers. This memorial, inspired by Jason Lee, furnished the friends of Oregon in Congress a body of useful information from actual settlers in the jointly occupied area, and was one of the influential early factors in bringing that portion of the Oregon Country south of the Columbia River under the American flag.[29]

While in the Washington area Lee visited several nearby communities in the interest of his mission. Lee and Brooks presented the claims of the Oregon Mission before the Foundry Missionary Society of Baltimore on the evening of December 19, 1838.[30] They remained at Baltimore and vicinity for about one week. Lee also held a meeting at Winchester, Virginia, one of the most southerly points visited by him. The little southern village donated $100 for the cause of Oregon missions.[31] Retracing his journey northward, Lee on January 3, 1839, delivered a "spirit-stirring" address at West Chester, Penn. The contribution of this generous audience was $225. Lee's eloquence drew this tribute from a listener who reported the meeting to the Christian Advocate: "Should brother Lee as effectively leave his mark wherever he goes the people will soon bring their tithes into the store-house of the Lord, and will open the windows of heaven and pour out upon the heathen a blessing that there shall not be room enough to receive it.[32]

A crowded meeting at Morristown, New Jersey, on January 10, 1839, brought to a close his southern tour. So deep was the interest of this gathering that "the church was much crowded at an early hour; scores who came at a distance were unable to gain admittance. The audience listened with fixed attention to the interesting address of Brother Lee." The *Advocate* report of this meeting contains this expressive phrase; "The collection and pledges amounted to $150, the most of which I will soon remit. The amount would have been greater but for the crowd.[33]

The initial meeting of Lee's New England tour was held at New Haven, Connecticut, on January 14, 1839. The address by William Brooks was a feature of this occasion. This is the way the young Chinook lad denounced the eastern ministers who were interested merely in the economic resources of his homeland, Oregon. "Great many minister, he ask me, ' You got everything good in your country?' I tell him, 'No, sir.' He ask me, 'You got plenty good houses in your country?' I say, 'No, sir.' Then he say, 'I not go in your country.' Now I don't call that Christian at all; I say, 'You stay *home,* sir'."[34]

On January 16 and 17, Lee was at Middletown, Conn. William Brooks' denunciation of white men who carried rum to Oregon Indians captured the attention of the large evening audience which greeted the misionaries in this college town. "One thing, my friends," said Brooks, "I must have put in paper [meaning in the newspapers] that no more these Americans bring rum into my country, spoil all Indians. He *make* it himself, he must *drink* it himself, these Yankees."

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[29]E. A. Linn and N. Sargent, *Life and Public Services of Dr. Lewis F. Linn* (New York, 1857), 224.
[30]*Christian Advocate and Journal,* XIII, 118 (March 13, 1839).
[31]*Ibid.,* XIII, 113, (March 8, 1839).
[32]*Ibid.,* XIII, 90 (January 25, 1839).
[33]*Christian Advocate and Journal,* XIII, 130 (April 5, 1839).
[34]*Ibid.,* XIV, 25 (Oct. 4, 1839).

(Continued on page 79)

North Idaho's Forestry Future[1]

By E. H. Myrick
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IN order to present a foundation upon which a prophecy of Northern Idaho's forest future can be based, it is first necessary to briefly review the trend that forestry has taken nationally, what has caused certain economic phenomena in the past, and the extent that those and other factors, now on the horizon of the industry, will affect local conditions in the future.

It was not very long ago that the timber resources of the nation were considered inexhaustible by the people as a whole, and little or no thought was given to further crops. As a result, the choicest timber lands of the East, South and Lake States were largely devastated, and to this day the progress made in better utilization of the logged product and preservation of immature and unlogged timber on an operation is regrettably small. Perhaps a resume of the timber development will indicate why progress along this line has been retarded.

The Forester's report for the fiscal year of 1929 clearly portrays the rapid expansion of the lumber industry in the nineteenth century and the steady decline in output and per capita consumption since 1906.

The reasons for the decline are many, but can in the main be listed under, increased use of substitutes, reduction in railroad construction, reduction in rural settlement and increased cost of lumber to the consumer.

The result has been a demand to curtail production in order to stabilize the market and offset the rapid liquidation of the timber resources under private ownership which is being done with little or no profit to the industry.

The timber land owner has been between the devil and the deep blue sea in that, on the one had, if he curtailed production, the increased carrying charges would eat up any possibility of profit, while on the other, liquidation would break down the market.

Liquidation has predominated the movement, however, and the necessity of keeping logging costs at a minimum has resulted in waste of inferior species, as well as the lower grades of the more valuable species, and has brought devastation of the logging areas as a whole.

A survey of the lumber industry of Northern Idaho, shows that the present conditions, if allowed to continue, have little in them that is encouraging. Logging is going on without regard to future production and the waste on the average operation is appalling. Slash disposal, so necessary to the protection of future crops of timber, is not being carried out, nor are the violators being brought to an accounting, although the State has a very strong slash disposal law.

Briefly put, the evidences on every hand, clearly indicate that nearly all of the timber land owners are cutting off their virgin stands of timber as fast as possible, sacrificing that which is unprofitable to cut, as well as, future crops, with the ultimate idea of getting out from under the tax and fire protection burden as soon as possible.

Wide acclaim has been given to the yield tax law passed by the Idaho legislature in 1929. It has been hailed as a great forward step in curing the ills of the timber industry. I do not question its value, but the problems facing the private owner of timber

1. Presented at the Annual Meeting of the Northwest Scientific Association, Dec., 27, 28, 1929, Spokane, Wash.

lands today cannot be cured with one kind of medicine. Something else must be done to assure better elimination of the fire hazard on logging operations, reduction in the careless use of fire-causing agencies by the timber land owners and others, more effective fire suppression, and a general change in timber harvesting, to the end that future crops are provided for.

The timber land owner cannot, and will not, create these things, for after all, he is controlled by the economic conditions, and unless there is a very good prospect for him eventually reaping a reasonable profit by the expenditure of funds necessary to bring these things into fact, he will restrict expenses to that necessary to protect his present operation, and the resultant devastated and fire trap areas will, in the end, largely revert to the County for taxes.

It is already too late for most operators in Northern Idaho to plan on handling their forest lands on a sustained yield basis. When it is once realized that the ultimate ownership of all but the choicest and more accessible forest lands will eventually rest with the County, State, and Federal Governments, and the public's efforts confined to having those lands turned over to them in such a state that another natural crop is in prospect, the better off will the country be in the long run.

At the present rate of cutting, practically all of the virgin timber lands under private ownership in Northern Idaho will have been cut off within about thirty years. Of course, the present rate will fall off as the supply dwindles.

During this transition period, many changes will come to pass. The people will have come to a realization of the great values to be derived from forests for watershed protection, for irrigation, water power and prevention of erosion, and will have taken decisive steps to perpetuate and receive the maximum benefits from them. The lands will have been classified, and definite policies adopted to assure forest growth on those having the highest values for that purpose.

The question of ownership will have been settled and definite responsibilities placed on all owners in the right way for harvesting forest crops.

The value of forest areas for recreation and for perpetuation of fish and game will have been established, and provisions made to insure their continuous enjoyment by the people.

While this has been going on, the lumber industry will have been going through an intense period of liquidation, the number of mills will have been greatly reduced, and markets stabilized through regulation of cut. Costs of local government will, of a necessity, have been reduced by consolidation of counties, or otherwise, to offset the loss in revenues resulting from reduction in forest values as the present merchantable stands are depleted, unless other sources of revenue from the permanent forest land areas be developed.

The country will be face to face with the realization that it need not be concerned so much with the timber supply of 50 years ahead, as with finding sufficient to meet the country's immediate needs.

Northern Idaho will always be an important lumber producing country for most of its lands are chiefly valuable for growing timber, and the people are not likely to stand by and let the present rate of devastation continue to the point of wiping out the source of their principal income.

The Value of Salt on Alkali Ranges in Southeastern Montana[1]

By T. LOMMASSON
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ONE of the perplexing questions in the management of ranges on which occur deposits of natural alkali is whether the use of common salt, sodium chlorid, is necessary to the welfare of the animals and whether such salt will be utilized where deposits of natural alkali are available. This question has been discussed from various points of view, the general concensus of opinion among stockmen being that on such ranges cattle would not use salt if it were placed on the range and that it was a waste of time and money to attempt to salt ranges having natural deposits of alkali. This opinion had become a deep-seated conviction with most oldtime cattlemen, and efforts to induce them to give salt a fair trial have been largely fruitless.

In order to obtain reliable information on the value of salt on alkali ranges a series of experiments were begun in 1925 on the Poker Jim Experimental Pasture, Custer National Forest, Montana, and continued during 1926 and 1927. This pasture is about 4,000 acres in size and represents a fair average of the alkali ranges in southeastern Montana. Cattle using the ranges in this region have resorted to the natural licks during the open season and have been given salt in very limited amount only while on the feedlot. The 350 head of breeding cows and bulls selected for this experiment had never been salted on the range and had been on the feedlot where salt was provided only during the more severe winters. Ordinarily they were wintered on the range without salt.

1. Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Wash.

The five points set up for determination were:

1. Whether cattle will use salt on the range where alkalies are available.
2. How much salt is consumed, if any.
3. Amount of salt obtainable through use of
   (a)—Alkali licks
   (b)—Water
   (c)—Forage
4. Whether total amounts obtainable from (3) meet the salt requirements of the animals.
5. Comparative condition at end of grazing period of cattle with access to salt and those having access to alkali only.

The cattle when first turned into the pasture took the salt sparingly but as they became more accustomed to it the use increased until the routes of drift became established between the watering places and the salt grounds. Comparative figures on the amount of salt used during the 5½ months grazing season for each of the three years indicate that the former lack of salt caused an abnormal appetite for it and during the first season the consumption per cow-month was 16 per cent greater than the two succeeding years previous to which they had had access to the salt in the pasture during the summer season.

The consumption of salt per cow month during the three seasons of use was as follows:

1925	.69	pounds
1926	.58	pounds
1927	.58	pounds
Average	.616	pounds

The amounts are considerably less than the average used on ranges having fresh water and no alkili. On such ranges salt consumption averages from 1 to 3 pounds a cow-month, the amount used depending upon various natural conditions. After the salt was placed

use of the alkali licks continued during the three seasons with no apparent reduction in the amount of use made of them.

Chemical analyses were made of alkali licks, water from springs and creeks and of samples of forage on this range to determine whether the amounts of NaCl (sodium chlorid) obtained from these natural sources was sufficient to meet the requirements for cattle.

Probably the most complete experimental work concerning the salt requirements of cattle was done at the University of Wisconsin and reported in the second annual report of that station in 1905. Work was done with dairy cows and all possible sources of salt were studied. Chlorine was found to be the essential part of salt. The cattle under test consumed one to eight ounces of salt per day with less than 2 ounces for the average consumption. Dry cows and steers were able to secure sufficient chlorine in feed and water to practically fill their needs for indefinite periods. The amount of salt obtained through feed was about one-half ounce per day. The work indicates that about three-fourths of an ounce of chlorine, or 1.15 ounces of salt per day are necessary to maintain a dry cow or steer in good condition. The amount would be higher for a cow with calf.

Hensel working in Kansas found that cattle which had daily access to salt used 1.17 pounds per month. This was the net amount of salt consumed not considering loss from weathering and other causes. At the Wisconsin Station it was estimated that an animal would secure about one-half ounce of salt a day from feed, or about .94 pounds per month. Applying this to Hensel's experiment would make a total of 2.11 pounds of salt per month secured from all sources compared to 2.15 pounds in the Wisconsin experiment. The average of these two results would indicate that an animal needs 2.13 pounds of salt per month. This amount is used as the requirement per cow month necessary to maintain a cow in good condition and as the unit against which the amount of available salt from natural sources in the Poker Jim Experiment is computed.

Results from the tests of the alkali licks showed that the amount of alkaline soil which an animal must lick in order to obtain one pound of salt would be as follows:

Lick 1—385 lbs. of soil to secure 1 lb. of salt.

Lick 2—833 lbs. of soil to secure 1 lb. of salt.

Lick 3—1250 lbs. of soil to secure 1 lb. of salt.

Such consumption of soil per pound of salt is obviously prohibitive.

If alkali were available without a mixture of soil it would require amounts as follows to obtain one pound of salt:

Lick 1—40 lbs. of alkali.
Lick 2—112 lbs. of alkali.
Lick 3—167 lbs. of alkali.

Free alakali in such amounts is not available. The small amounts which are present in comparatively pure form occur at the edges of waterholes as the result of capillary action and evaporation of alkaline water during the dry season. If sufficient amounts were available their use in such quantities would be prohibitive. Any amount of salt obtainable from this source is therefore negligible.

Analysis of the salt content of the water shows a variation in the amounts of NaCl available per cow-month of from a minimum of .2 oz. to a maximum of 1.3 oz. with an average of .8 oz. assuming that the animal drank ten gallons of water per day which represents a fair average. This amount is so small as to be almost negligible when it is considered that the requirement is 2.13 lbs. per month.

Samples of representative combin-

ations of forage showed the average salt content of forage to be 2.75 per cent of the ashed weight. The winter maintenance ration for a cow in this region is 600 lbs. of hay per month. This is only sufficient to maintain the animal and is not sufficient to cause any gain in weight. Assuming that the consumption of grass during the summer months is 30 lbs. dry weight per day, or 900 lbs. per cow-month, its salt content would be 3.93 lbs. If 600 lbs. a month were used the amount of salt obtainable would be 2.62 lbs. a cow month.

The total amount of salt available from alkali, water, and forage then would be:

Alkali—negligible.

Water—.8 oz. per cow-month.

Forage—62.88 oz. per cow-month.

Total—63.68 oz. per cow-month.

Total from alkali water and forage	3.97 lbs.
Total commercial salt licked	.61 lbs.
Total consumed	4.58 lbs.
Minimum requirement	2.13 lbs.
Amt. used over requirement	2.45 lbs.

The cattle used in the experiment were breeding cows, 60 per cent with calves. These cattle were active and travelled some distance for forage and water, and all gained weight while on the range. The minimum average requirement as shown by former experiments is 2.13 lbs. per head per month, while the total amount obtained by the range stock from natural sources was 3.97 pounds a month. In addition to this .61 lbs. of commercial salt was consumed, making the total actual consumption per head per month 4.58 lbs., or 2.45 lbs. more than the minimum requirement.

The cattle coming off adjacent ranges where no commercial salt was available were in prime condition and equal to any which came off the pasture where salt was placed. This indicates that sufficient salt is obtainable from natural sources to maintain a breeding, growing or fattening animal on the range.

The use of commercial salt is apparently an acquired habit on the alkali ranges of southeastern Montana. The use of commercial salt has its chief value in its influence on distribution of stock over the range. This was demonstrated during the experiment by the improved distribution obtained when salt was placed on areas where utilization of forage was formerly insufficient.

Conclusions

1. Cattle will use an appreciable amount of salt on range where alkali is plentiful.

2. Alkali licks will not supply sufficient salt for cattle because of the prohibitive amount of soil which it is necessary to lick in order to obtain the required amount.

3. Water in southeastern Montana contains only a small amount of salt.

4. Forage in southeastern Montana contains sufficient salt to maintain cattle in good condition.

5. The amount of salt obtainable from water and forage exceeds the minimum requirement necessary to keep a cow in good condition.

6. Results indicate that range cattle gaining in weight will use more salt than the average minimum requirement.

7. Cattle come off of alkali ranges where no commercial salt is available in equally good condition as those coming off the range where both alkali and commercial salt are available.

8. The greatest value of commercial salt on the alkali ranges of southeastern Montana is for the purpose of obtaining a more uniform distribution of cattle over the range.

Literature Cited.

Wisconsin Experiment Station, Twenty-second Annual Report, 1905. Hensel, R. L. Experiments with salting range livestock, Ms. 1921.

Babcock & Carlyle, The addition of salt to the ration of dairy cows.

Some Aliphatic Organic Compounds of Selenium

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IT is hoped that a systematic presentation, of which this is a part, of the chemistry of organic selenium compounds, with a statement of the synthetic work accomplished to date, will create interest in developing the dyes, medicinals, and other useful compounds which exist in this field. Many selenium organic compounds are reported to exhibit valuable therapeutic and tinctorial properties. Others are in use in commercial "anti-knock" mixtures. Investigation in this field, which is easily conducted with only the most ordinary equipment, could well be carried on in the smaller and more poorly equipped schools. This paper will discuss the known aliphatic selenium analogues of alcohols, aldehydes, ketones, and acids, and will present a complete bibliography of the literature pertaining to the compounds of these groups.

Aliphatic selenols or seleno mercaptans have been prepared in the absence of air by the interaction of (a) an alkali acid selenide or H_2Se and a calcium or potassium alkyl sulfate, (b) an alkali acid selenide and an alkyl iodide or bromide, (c) aluminum selenide or H_2Se and an alkyl alcohol at 250-300° C., and (d) by the decomposition of selenocyanates. Only three aliphatic primary selenols, R-SeH, ethyl (1, 2, 3, 4, 5, 6, 7),

(1) Tschugaeff,L., Ber. XLII, 49-54 (1909).

(2) Lowing,C., Organische Chemie, II, 432 (1846).

(3) Siemens, C., Ann LXI, 360-62 (1847).

(4) Shaw, E. H. Jr. and Reid, E. E., J. Am. Chem. Soc. XLVIII, 520 (1926).

(5) Natta, G., Chem. Zentr. XCVIII, (i) 415 (1927).

(6) Pieverling, L. von, Ann. CLXXXV, 331-39 (1877).

(7) Hilditch, T. P. and Smiles, S., J. Chem. Soc. XCIII, 1384-7 (1908).

n-propyl (1), and n-butyl selenol (1) have been prepared. They are heavy, colorless, easily oxidizable liquids which are insoluble in water. The only aliphatic secondary selenol, $R_2{=}CHSeH$, which has been prepared is isopropyl selenol (5). No mention of tertiary selenols, $R_3{=}CSeH$, or of selenide selenols, R-Se-SeH, is found in the literature.

One selenonium selenol, R-Se-SeH, triethyl selenonium selenol (8),

8) Pieroni, A. & Coli, C. Gazz. chim. ital. XLIV ii, 349 (1914).

perhaps better named triethyl selenonium hydroselenide, $(C_2H_5)_3{\equiv}Se\text{-}SeH$ has been described. The divalent selenium atom reacts with $AgNO_3$ to form Ag_2Se and in this respect does not resemble the selenium of a true selenol.

Selenoaldehydes, R-CHSe, have been prepared by the action of H_2Se on a concentrated HCl solution of the corresponding aldehyde and by treating an alcoholic solution of K_2Se with a derivative of dichloro methane. Only three aliphatic selenoaldehydes have been prepared. They are selenoformaldehyde, $(CHSe)^n$ (9),

(9) Vanino, L. —Schinner, A., J. pr. Chem (2), XCI, 116-127 (1915).

selenoacetaldehyde, CH_3CHSe (9) and selenoisovaleraldehyde, $(CH_3)_2{=}CH\text{-}CH_2\text{-}CHSe$ (10),

(10) Schroder, A., Ber., IV, 403 (1871).

melting respectively at 215° C., 139° C. and 56.5° C. The selenium analogue of acetaldehyde apparently exists in several modifications.

The two known aliphatic seleno-

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ketones, R_2=C=Se (11),

(11) Lyons, R. E. and Bradt, W. E., Ber. LX, 824-26 (1927).

have been prepared by treatment of a concentrated HC1 solution of the corresponding ketone with H_2Se. Each has been isolated in a bimolecular form. Those formed are diselenoacetone, CH_3-CSe-$CH_3)_2$, and diseleno-methyl-ethyl-ketone, (CH_3-CSe-$C_2H_5)_2$. Each is a red, viscous, unstable oil, immiscible with water, and possesses a very disgusting odor.

Organic selenium acids may be divided into five types: (a) selenol acids, R-C=O-SeH, (b) seleno acids R-C=Se-OH, (c) selenol-seleno acids or "diseleno" acids, R-C=Se-SeH, (d) seleninic acids, R-Se=O-OH, and (e) selenonic acids, R-SeO_2-OH. No aliphatic and only one aromatic selenol acid, selenol benzoic acid (12),

(12) Mingoia, Q., Gazz. Chim. ital. LVI, 835-9 (1926)

or "*alpha* selenobenzoic",

C_6H_5-C=O-SeH, has been prepared.

Although no seleno acids have been isolated, one aliphatic seleno acid amide has been prepared by the action of H_2Se on the corresponding cyanide. Methyl selenoamide (13)

(13) Kindler, K., Ann. CDXXXI, 187-231 (1923),

or "seleno acetamide", CH_3-CSe-NH_2 was prepared as colorless crystals (m.p.=126-126.5° C.) in 17% yield by this method.

The only known representative of selenol-seleno acids, is the ethyl ester of selenol-seleno carbonic acid. The potassium salt, C_2H_5-O-C=Se-SeK, (14, 15)

(14) Rathke, B., Ann. CLII. 181-220 (1869).

(15) Bartal, A. von, Chem. Ztg. XXX, 1044-45 (1906).

which has been isolated and which is usually called potassium seleno xanthogenate was prepared by the action of CSe_2 on C_2H_5OK.

Seleninic acids, R-Se=O-OH, were among the organic selenium compounds first prepared. Consequently there is some confusion (14, 16, 17),

(16) Wohler, F. and Dean, J., Ann. XCVII, 1-9 (1856).

(17) Proskauer, B. Ber. VII, 1279-82 (1874).

formula for one or two of these compounds. Methods of preparation include the oxidation of diselenides, R-Se-Se-R, by HNO_3, alkaline $KMnO_4$, or alkaline H_2O_2, the oxidation of selenols by nitric acid or alkaline $KMnO_4$, the action of HNO_3 on selenocyanates, R-SeCN, the action of H_2O_2 or HNO_3 on the diethyl selenomercaptoles, R_2=(Se-Et)$_2$, of a few ketones, and the reduction of the corresponding selenonic acid, R-SeO_2-OH, with concentrated HC1. The four known aliphatic seleninic acids are methyl seleninic acid, CH_3SeOOH, (4, 14, 16). methane diseleninic acid, $CH_2(SeOOH)_2$, (17), ethyl seleninic acid, C_2H_5SeOOH, (4, 14, 18, 19),

(18) Karve, D. D., J. Indian Chem. Soc. II, 128-141 (1925).

(19)) Joy, C. A. Ann. LXXXVI, 35-39 (1853).

and ethane diseleninic acid, C_2H_4(Se OOH)$_2$ (17). Methyl seleninic acid was first formed as the nitric acid compound, $CH_3SeOOH.HNO_3$ (m.p.= 122° C.) from dimethyl diselenide The ammonium, barium and silver salts have been prepared.

The action of nitric acid on methane diselenocyanate and on ethane diselenocyanate was reported in 1874 to give the diselenonic acids. In no case is HNO_3 known to oxidize selenium beyond the tetravalent stage (20).

(20) Lyons, R. E. and Shinn, F. L., J. Am. Chem. Soc. XXIV, 1087-93 (1902).

Consequently, the products were probably not selenonic acids, but were methane diseleninic acid and ethane *alpha-beta* diseleninic acids. No analysis was reported.

As early as 1852, diethyl diselenide

was treated with strong nitric acid, and, although ethyl seleninic acid, $C_2H_5.SeOOH$, (m p.=80° C.) was certainly formed, it was not then isolated. Later, however, on the addition of HC1, it was isolated as a crystalline product, which was first reported (19) as $2C_2H_5.SeO.OH.C1$, but which was shown (14) in 1869 to be $C_2H_5SeOOH.HC1$. Ethyl seleninic acid was recently (4) prepared by the oxidation of ethyl selenol by HNO_3 and by oxidation of the diethyl seleno mer-the captole of acetone, $R_2=C=(SeC_2H_5)_2$ by HNO_3 or 3%H_2O_2. Because treatment of the nitric acid compound of ethyl seleninic acid with HBr formed ethyl selenonum tribromide, $C_2H_5SeBr_3$, a selenonum formula, $C_2H_5Se\text{-}\begin{matrix}OH\\Br\end{matrix}$ for the acid compound is probably more correct (4).

Selenonic acids may be prepared by the action of concentrated H_2SeO_4 on a hydrocarbon (21, 22, 23, 24).

(21) Chabrie, M. C. Bull. Soc. Chim. (2), L, 133-137 (1888) and (3), II, 796 (1889).

(22) Doughty, H. W. and Elder, F. R., Eighth Inter. Cong. App. Chem. VI, 93-101 (1912).

(23) Anschuetz, R. and Teutenberg, F. Ber. LVII Ab.B., 1018-1023 (1924)

(24) Anschuetz, R. and Kallen, J. and Reipenkroger, K., Ber. LII, 1860-75 (1919).

or by the oxidation of a tetravalent organic selenium atom. Aqueous chlorine, (25).

(25) Doughty, H. W., Am. Chem. J. XLI, 326-337 (1908).

alkaline permanganate, (22, 26, 27, 28, 29).

(26) Pyman, F. L., J. Chem. Soc. CXV, T, 166-75 (1919).

(27) Pyman, F. L. Proc. Chem. Soc. XXX, 302-3 (1914).

(28) Lesser, R, nd Weiss, R., Ber. XLVI, 2640-2658 (1913).

(29) Lesser, R. and Weiss, R. Ber. XLV, 1835-41 (1912).

and 30% H_2O_2 (30)

(30) Michaelies, A. and Langenkamp, P., Ann. CDIV, 21-36 (1914).

in acetic acid have been used. Methyl selenonic acid, CH_3SeO_3H, (16) is the only known aliphatic acid mentioned in the literature. This has not been isolated and its preparation is not at all well established. In 1856, Woehler and Dean precipitated the hydrochloride of methyl seleninic acid by adding HC1 to a dilute HNO_3 solution of methyl seleninic acid. However, they observed that the addition of HC1 to a concentrated HNO_3 solution failed to form a precipitate of $CH_3SeOOH.HC1$. It is very possible that the selenium was oxidized by the acid mixture with the formation of a soluble methyl selenonic acid. Although methane diselenonic acid and ethane *alpha-beta* diselenonic acid are still listed in Beilstein, the authors are inclined to consider this an error for resons discussed above. The ethyl selenonic acid, (31)

(31) Fabian, Chr., Ann. Spl. I, 241-250 (1861).

which was reported in 1861, was in reality an ethyl ester of selenic acid and was erroneously named.

A brief resume of the known work on other classes of aliphatic selenium organic compounds will be presented in later papers.

Jason Lee's Part In the Founding of the Commonwealth of Oregon

(Continued from page 71)

Jason Lee, later referring to this remark by young Brooks, wrote: "The manner of delivering the above was such as simultaneously to excite the risibles of nearly every one in the house; and the lamented Dr. Fisk, who sat on the platform behind the pulpit, laughed more heartily than I remember to have seen him on any other public occasion."[35] President

[35] *Christian Advocate and Journal* XIV, 25 (Oct. 4, 1839).

Fisk, of Wesleyan University, despite his sufferings from the last stages of a fatal illness, honored this meeting with his presence. The plea, which this towering figure of Methodism made at this meeting, proved to be his last public utterance in support of Lee's Oregon mission. His presence reflected not merely Dr. Fisk's deep concern for the cause of missions, but his abiding interest in his former student. When, less than five weeks later, death closed Dr. Fisk's brilliant young career, the Methodist church lost one of its most unselfish and consecrated servants, and Jason Lee mourned a patron and friend.

On January 17, 1839, while still at Middletown, Jason Lee wrote his historic letter to Caleb Cushing, chairman of the House Committee on Foreign Relations. Lee's reply to Cushing's request for Oregon information, coming as it did from an actual resident, stands to this day as one of the best brief arguments in favor of American occupation of Oregon. Representative Cushing included Lee's letter as a part of his illuminating report on Oregon, which was published as House Document, Number One Hundred and One. In this form, on February 16, 1839, 10,000 copies of Lee's letter were immediately printed by Congress.[36]

On January 18, 1839, Lee held a missionary meeting at Hartford, the capital city of Connecticut. Here "the crowd was immense; hundreds went away unable to gain admittance into the church."[37] By rapid winter stage journeys, Lee now completed his tour of Connecticut cities. On January 20, he addressed the two large Methodist congregations of Norwich, which assembled in the spacious East Chelsea Church. William Brooks at this gathering touched the emotions of his large audience by a feeling tribute to his former Oregon teacher, the late Mrs. Jason Lee. On January 21, 1839, Jason Lee spoke at New London and West Thompson, Conn. The Zion's Herald report of the West Thompson evening meeting is a vital document that makes this century-old winter missionary gathering live again for the reader of a later radio and airplane civilization. Two days later Lee held a misionary meeting at Providence, Rhode Island. This was the only city visited by Lee in that state. The following day, Jason Lee held his first Massachusetts meeting at Foxborough, on January 24, 1839. Although his schedule called for a meeting at Lynn the following evening, he was persuaded by a former Wilbraham Academy friend to lecture at Walpole. The *Zion's Herald* report of this meeting reflects the welcome which Lee received at this little town. The freindly reporter wrote that Jason Lee's presence brought to his remembrance "scenes of other years when the cares of life were only seen in prospect." He continues by recording that "notwithstanding the severity of the weather, the interest of the occasion was manifest in an assemblage larger than our chapel could contain." That Lee's young Indian campaign assistant reached the sympathies of his audience is reflected in the reference to the fact that the Chinook lad received " a present of a pair of boots . . . . from a gentleman employed in the boot factory."[38] Continuing northward, Lee closed his first week in Massachusetts by holding meetings at Lynn and Charleston. On Sunday afternoon, January 27, his vigorous itinerary called for a meeting at Newton Upper Falls.[39]

On that same Sunday evening, Lee and William Brooks held the most notable meeting of Lee's entire career.

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[36]House Report, 101, 25 Cong., 3 Sess., pp. 3 4.
[37]*Christian Advocate and Journal,* XIII, 94, (Feb. 1, 1839).
[38]*Zion's Herald,* X, 26 (February 13, 1839).
[39]*Ibid.,* X, 17 (January 23, 1839).

This was Lee's meeting at the Bromfield Methodist Church at Boston. The desire of the Boston public to hear of Lee's missionary enterprise is mirrored in announcements of the sale of tickets in issues of *Zion's Herald.*[40] A careful study of Jason Lee's address, which received the compliment of being reported in full in the conservative and well-edited *Zion's Herald,* makes clear to the modern reader why Jason Lee touched the hearts and opened the pocket books of his eastern audiences. In the first place, his theme, a message from the romantic land of the "Flat Heads," was of deep interest to missionary workers everywhere. In 1839 remembrance was still fresh of the story of those four Flatheads from the Rocky Mountains who made their long pilgrimage to St. Louis and there poured forth their pathetic plea for the white man's re- actual resident of that far-away and ligion. Then, again, Lee came as an jointly occupied region, which bore the romantic name of Oregon. Boston although separated from Oregon by 3,000 miles of continent, was bound to that distant land by the closest of historical ties. As early as the eighteenth century, Boston whaling ships and Boston fur traders had borne back to their Massachusetts ports marvelous tales of the Northwest Coast.[41] Boston was, moreover, the home of Oregon's first notable publicity expert, Hall J. Kelley. Following closely the pioneering efforts of Kelley, came the two widely heralded Oregon expeditions of Nathaniel J. Wyeth, the Cambridge ice dealer. Although Wyeth's plan of erecting an American mercantile establishment on the banks of the distant Columbia, failed, yet his magnificent undertaking stood forth in Jason Lee's day, and still remains, one of the clearest-headed business projects launched in Old Oregon by any American business man since the days when Astoria rose and fell.

Jason Lee's Boston speech is a sincere and unadorned narrative. It probably ranks as the most graphic piece of source material that tells the story of the planting of Oregon's first mission. It leads the present-day writer unconsciously into the atmosphere of that autumn day in 1834 when Lee's little missionary party threaded its cautious way up the Willamette Valley, hemmed in by its mountains and shrouded in its wild and primitive beauty.[42]

On the Monday evening following his Boston lecture, Jason Lee filled an appointment in the factory city of Lowell, Mass. Here he experienced unfavorable weather conditions. During the afternoon and evening "a large quantity of snow fell . . . the wind blew very hard, and the weather was severely cold." Despite these climatic handicaps, however, Lee addressed a large audience in the spacious Wesley chapel on Suffolk Street.[43]

Proceeding northward by winter stage, Jason Lee, with his usual promptitude, was on hand to meet his engagement at Newburyport, Mass., on February 1, 1839. Although Lee arrived in Newburyport during the harsh winter season, the observant missionary could not have failed to note the distinctive sights of this old New England port. Here, where the Merrimac flowed into the sea, was a coast city, which shared with Boston and Salem the honor of being Massachusetts' leading port. Here lay a city which looked out upon "waters that washed other continents." Here on aristocratic High Street lived a race of merchants who had "won or lost

---

[40] *Ibid.,* X, 17, (January 23, 1839).

[41] Samuel Eliot Morison, Professor of History, Harvard University, "From Fish and Furs to Municipal Bonds," *Oregon Voter,* XLVI, 4-26 (August 14, 1926).

[42] *Zion's Herald,* X, 22 (February 6, 1839).

[43] *Zion's Herald,* X, 30 (February 20, 1839).

fortunes by a turn of wind and waves." Here dwelt a race of maritime men to whom "the scent of salt spray was like tonic."[44]

Newburyport was also the home of Oregon's Congressional friend, Caleb Cushing. This well-known public man was a member of the maritime firm of Cushing and Company. During his brief Newburyport visit, Lee was successful in interesting this company in the possibilities of profitable trading relations with Oregon. In 1840 Captain John H. Couch, a representative of the Cushings, arrived in Oregon on the brig *Maryland*. Here he undertook to lay the foundations of future maritime trade, based mainly on the salmon industry. Attracted by the economic opportunities of the new region, Couch returned to Oregon in 1842 on the Cushing brig *Chenamus*, and later he became a prominent resident of Oregon. He established a land claim on the site of the city of Portland and gradually built up a good-sized fortune. His Portland residence was one of the earliest structures erected in what is now the attractive metropolis of Oregon.[45]

A pleasant incident associated with Lee's Newburyport meeting was his visit with the Rev. Jefferson Hascall, a former Wilbraham Academy classmate. Mr. Hascall, who was at this time the Newburyport Methodist pastor, extended a cordial welcome to his "good and tried friend Brother Lee." An intense admiration for Dr. Wilbur Fisk, then in the last weeks of a fatal illness, was shared by both men and proved a bond that drew these friends together.[46]

A visit to Portland concluded Lee's New England tour. This last formal meeting resulted in an Oregon Mission collection of about two hundred dollars and brought to a fitting close one of the really successful tours in Methodist missionary history. The report of the meeting states, "It was advertised that the people would be admitted by tickets but this was dispensed with." The report continues with the information that "the house was filled to the utmost, and hundreds went away who could not gain admittance." An incident connected with the Portland meeting is illustrative of the fact that Jason Lee's stirring appeals reached a public beyond the bounds of his own denomination. "On the following evening," states the same account, "Brother Lee met, by invitation, the Congregational Churches, at their Monthly Concert. He addressed the meeting at length, and William Brooks gave a short address. A collection was taken, which is to be equally divided between the Methodist and Congregational Missions in Oregon."[47]

From Portland Jason Lee now departed for a short visit to his boyhood home at Stanstead, just across the Vermont line, in what was then called Lower Canada. A leisurely winter stage journey, interrupted by several informal missionary meetings, brought him to Stanstead about February 15, 1839. After enjoying a three weeks' visit with relatives and neighbors, he was again on his way to New York City. A trip through the muddy roads of northern Vermont brought him to Montpelier, the capital of the state, on March 17, 1839. It was while engaged in holding meetings in the Montpelier area that Lee met his future wife, Lucy Thompson, of Barre. Leaving the Montpelier region about March 19, Lee continued toward New York City by way of the Hudson River Valley route. After a leisurely southward journey, interrupted here and there by missionary meetings, he

[44]Claude M. Fuess, *Caleb Cushing* (New York, 1923), 9, 10.

[45]Bancroft, *History of Oregon*, I, 221 and passim; Joseph Gaston, *Portland, Oregon; Its History and Builders* (Chicago, 1911), II, 374-376.

[46]*Zion's Herald*, X, 42, (March 13, 1839).

[47]*Ibid.*, X, 30, (February 20, 1839).

arrived in New York City in the last week of March, 1839.[48]

Lee's southern and New England tours established his reputation as one of the most effective missionary campaigners of his time. He was now requested by his Mission Board to make a final tour in New York State. This vigorous farewell speaking expedition began at Albany on April 21 and was concluded at Schenectady on May 12.[49] In this interval Jason Lee spoke to crowded congregations and assemblages and successfully met, without a single omission, each of the seventeen formal speaking engagements to which he was assigned. Lee's own report of his journey through those attractive New York communities as he found them in the spring days of 1839 is a revealing document:

"A great portion of the country through which we passed is most delightful, and produces most luxuriant crops. The farmers are becoming rich. I would to God, that each would lay by in store, according as God blesses him, for the purpose of sending the Gospel to enlighten others, that they may appreciate and labor for the blessings of civilization, and, above all, the durable riches and righteousness that fadeth not away.

"Three nights I did not go to bed at all, having to travel in order to meet my appointments; but, by the blessing and kindness of God, I am now enjoying my usual health. I will just add for the information of friends (and I hope they will remember it two hours), that we expect to sail the first of September—that we hire our passage, pay tonnage for freight—seven month's voyage—touch at the Sandwich Islands—don't know when I shall come back—make no calculations about it—but hope, by the blessing of God upon our unceasing efforts, to make a country fit to live in, and fit to die in; and have no choice, but would as soon lay my bones in that country as in this."[50]

[48] *Christian Advocate,* XIII, 113, 136, 137; *Zion's Herald,* X, 38, 41, 46, 58, 66.
[49] *Christian Advocate,* XIII, 160.
[50] *Christian Advocate,* XII, 168, (June 7, 1839).

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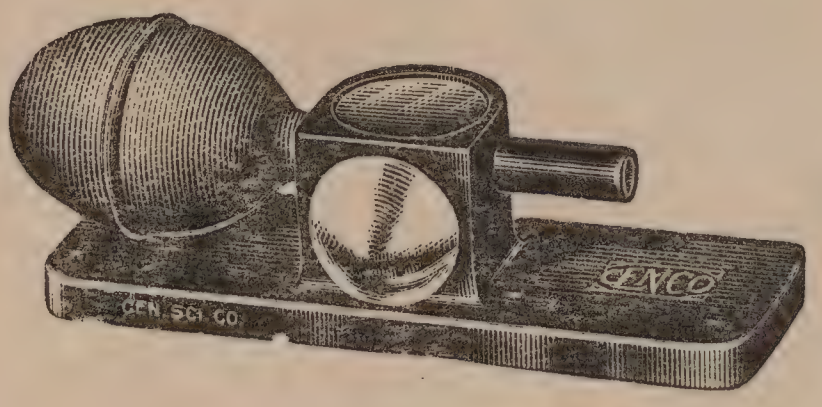

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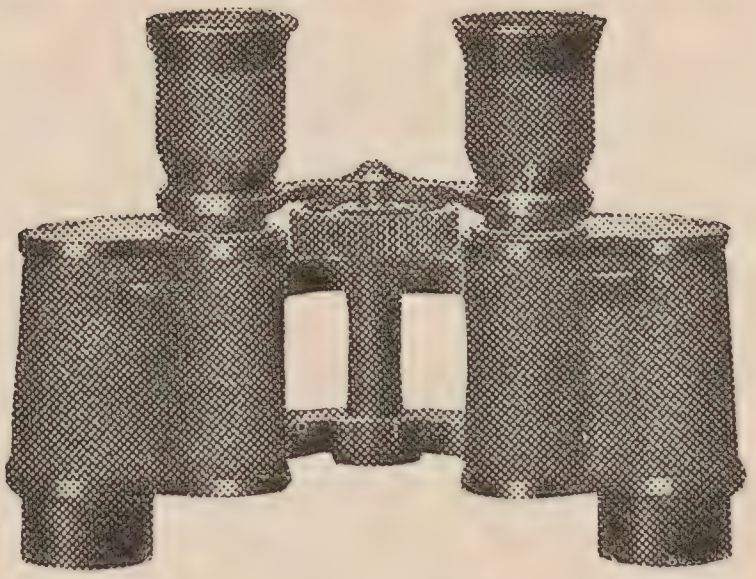

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NORTHWEST SCIENCE

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The Association is not responsible, as a body, for the facts and opinions advanced in the papers published by it.

Let Us Take Stock of Ourselves

SCIENTIFIC research by individuals and institutions of the Pacific Northwest apparently began in the early nineties, although of course much scientific work had been done in this region by federal agencies, particularly by the U. S. Geological Survey and its predecessors the Hayden & Wheeler surveys, long prior to that time. With the establishment and growth of the Agricultural Experiment stations, the decade prior to 1900 saw a great expansion in research, and a marked change in point of view on the part both of the colleges and of the public of the west toward the application of science to common human welfare, and from the application of chemistry, physics, and biology to the problems of the farm came a gradual realization of the applicability of the basic sciences to the advance of these western commonwealths through the utilization of their natural resources. Pioneers, however, are always and of necessity skeptical of science, by nature and by experience they have ever been empiricists.

Nevertheless, it is strange that not until nearly forty years after science had gained a definite foothold in the colleges and universities (and ultimately in the high schools) of the country lying north of the Columbia and west of the Rocky Mountains, did those in this region whose interest lay in the field of science, organize themselves for mutual acquaintance and the exchange of information.

"*The promotion of scientific research and the diffusion of scientific knowledge* was the splendid slogan of the small group of men from Idaho, Montana, and Washington who on April 6th, 1923, organized themselves as the Northwest Scientific Association at Spokane. Forty-five charter members were enrolled and in less than eight years the membership has grown to over 350.

Publication of Northwest Science to provide a "diffusion medium" began with the issue of March 1927, as Vol. I, No. 1, and the present issue is of course Vol. IV, No. 4.

The Association has justified the hopes of its founders, the quarterly journal is a credit to its editors and its contributors.

Nearly 150 papers, or abstracts of papers presented at the annual meetings have been published in Northwest Science, and alas! at least half as many were read at the metings but not turned

over to the editor. The geologists, the botanists, and the bacteriologists have been the most prolific contributors.

This much by way of review, what of the future?

What About New Members

Many teachers of science and many workers in various scientific fields are not yet interested. One of my colleagues when approached last fall with a view to becoming a member; shied off and said, "That's some kind of a political organiaztion, isn't it?" But he was prevailed upon to attend the meeting and was delighted with the opportunity to meet other men in his field, most of whom he knew by reputation but had never seen in the flesh, and he found the organization wholly *non-political,* of course.

This experience is illuminating—most of those who should be members, but are not, belong to their national societies and are apt to be a bit skeptical of the value of a somewhat local organization such as ours. On the other hand few of them have the opportunity to attend these national meetings and the value to them of attending the N .W. S.A. meeting and of making a contribution to the sessions, and rubbing shoulders with their fellow-workers is indisputable. Is it not the duty of every member to point out to such persons the satisfaction of being affiliated with others of like interest in neighboring states and of his obligation as a scientist to lend encouragement to the objects of the Association.

In 1932 the Pacific Division of the American Association for the Advancement of Science *can* be brought to Spokane, if we are willing to make the effort and I believe we will; also, should we as an association establish affiliation with the American Association, provided a satisfactory financial arrangement can be worked out by which we do not lose our identity?

What About Research?

Can we do anything that we are not now doing "for the promotion of scientific research"? The private donor is a *rara avis* in the Pacific Northwest, and apparently we must look for aid in such matters to federal and state agencies. Is there not some missionary work which we as an Association should be doing to make our representatives in the national and state capitols more fully conscious of the need for scientific research if the stream of economic development is to be kept from stagnation?

What About the Diffusion of Scientific Knowledge

Are you satisfied with Northwest Science? If not what would you like to see changed about it? The editors past and present are deserving of all our commendation. Their's is a rather thankless task yet one of the most vital, certainly the editorship is a more important and necessary office than the presidency.

What About The Annual

You are coming of course. If you do not contribute a paper, will you not make a point to contribute to the discussion? Discussion is the life-blood of such an organization as ours. He was a wise counsellor who admonished his followers to neglect not the assembling of themselves together.

And finally, will you not bring with you one of your scientific friends as a guest of the association? Give him the exposure and the secretary will do the rest!

FRANCIS A. THOMSON,
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Our Increasing Heart and Blood Vessel Mortality[1]

By Dr. D. A. Palmer
Physician, Spokane, Wash.

HEART disease today heads the list in both mortality and morbidity and is the most outstanding problem in contemporary preventive medicine. To it rightfully should be added arterio-sclerosis, cerebral hemorrhage, which is the result of an arterial accident, and chronic Brights disease; because the heart, blood vessels and kidneys, comprising the cardio-vascular-renal system, are very dependent each upon the others, and rightfully should be considered together. In the year 1928, according to the statistics of the Metropolitan Life Insurance Company, the death rate for these three diseases was 271 out of a total of 786 per 100,000, excluding accidental external causes of death. This gives a mortality percentage for the group under discussion of 34.5 percent. A comparison of these figures with those for 1911 and those from 1918 to 1927 inclusive, reveals a slowly but definitely increasing mortality.

If it were true that cardiac mortality is limited chiefly to the aged, it would not greatly concern us for that it as good a mode of exit as any. Unfortunately, altogether too many children and young adults are dying or being incapacitated with heart disease. In the United States registration area for 1926, heart disease was responsible for more deaths in children than was scarlet fever, for almost one half as many as diphtheria, and for two-fifths as many as measles. Furthermore, many men and women are daily being taken from us in the prime of their lives, and at the height of their usefulness. There are now over 225,000 people dying annually of heart disease, and it is estimated that there are ten times that many partially or completely disabled, this disability extending over months or years. The economic loss is astounding, to say nothing of the suffering and privation of the patients themselves, and their relatives.

The question then arises as to whether this increase is due to the fact that more people are living to the age at which heart disease takes its largest toll, or is the risk of dying of heart disease greater now than it used to be? What is the effect of our present mode of living with the crowding of our population in the cities, our irregular habits of eating, sleeping, exercise and recreation, and the relatively increased nervous tension?

The mean length of life has been increased by twenty years since the introduction of active public health work in the latter part of the last century. Upon first consideration this fact might give us a false sense of security. People are not living to a greater age than they used to, but more of them are surviving the diseases of infancy and childhood, thus raising the general average.

This reduction in infant and young adult mortality is the result of tremendous strides which have been made in the control of feeding disturbances and the infectious diseases. The reduction in incidence and mortality in diphtheria, scarlet fever, typhoid fever, typhus and yellow fever, small-pox, the diarrheas of infancy, etc., need only be mentioned. The removal of foci of infection such as diseased tonsils and teeth are also responsible for much improvement.

Perhaps the most outstanding success of preventive medicine is in the field of tuberculosis. The mortality

1. Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 27, 28, 1929, Spokane, Wash.

from this disease has been cut in half and it is now relegated to fifth place in the causes of death. This remarkable feat has been accomplished through a long, well managed, organized program with splendid co-operation between the state, private and professional institutions and societies. Furthermore, there has been an awakening of the public consciousness and people are now seeking much earlier medical advice for cough, expectoration, loss of weight, and the other symptoms of phthisis.

Our attention has been centered upon the above conditions and we have only recently begun to recognize the importance of the degenerative diseases of middle life. The chief of these is heart disease, which is not due to one, but to a combination of many related disorders.

The heart is a muscular pump composed of four chambers divided in pairs into right and left halves. The blood coming from the general circulation enters the right upper chamber, or auricle, and then passes thru a valve into the lower right ventricle from whence it is pumped to the lungs and aerated. Returning, it enters the left upper chamber, or auricle, passes thru a similar valve into the lower left ventricle whence it is pumped to the general circulation. The heart muscle itself is nourished by blood supplied through small arteries called the coronary arteries.

This entire pumping mechanism is controlled by a rather complex nervous structure connected with the sympathetic nervous system. Through this means, many influences outside of the heart itself, such as worry, fright, sorrow, or other emotional stress may accelerate or retard the heart rate. These so-called functional disturbances result in no damage to the heart structure, except when they extend over a long period of time.

However, organic heart disease comprising diseases of the valves, muscle, or arteries, presents an entirely different problem. A large percentage of these result from the acute infectious diseases occurring chiefly in childhood. It is estimated that 25 per cent of organic heart disease results from acute rheumatic fever and that at least 65 per cent of cases of rheumatic fever are complicated by heart lesions. This disease attacks not only the heart muscle, but also the valves causing vegetative growths or acute endocarditis. In the acute and the later chronic stages there results a partial leakage of the involved valve requiring a compensatory enlargement of the heart chamber, and an increase in the size of the muscle. There is always considerable danger of the reinfection of these valves or the reactivation of an old chronic infection.

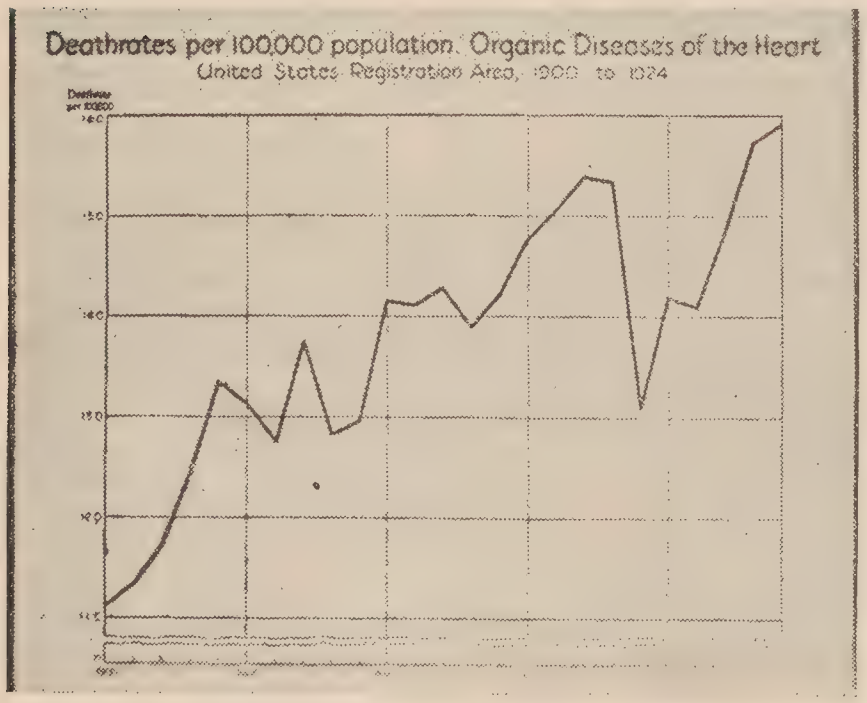
The incidence of syphilis as a cause of heart disease has been given as high as 10 per cent. This figure is perhaps a little high, but nevertheless, syphilis remains as an important etiological factor.

About 15 per cent of cardiac cases result from an attack of goitre, or a number of other primary disorders.

The most common form of heart disease, comprising 40 per cent of all cases, is associated with hardening of the arteries, or high blood pressure, and is that usually found in middle and later life. The coronary arteries supplying the heart muscle often become occluded somewhere in their course, resulting in the malnutrition and weakening of that part of the

heart muscle. This causes chronic myocarditis, or myrocardial degeneration. It may develop very slowly over a long period of time, or may come suddenly as angina pectoris with violent pain, collapse and often sudden death. Although the exact nature of angina pectoris is unknown, we do know that it is almost always associat-

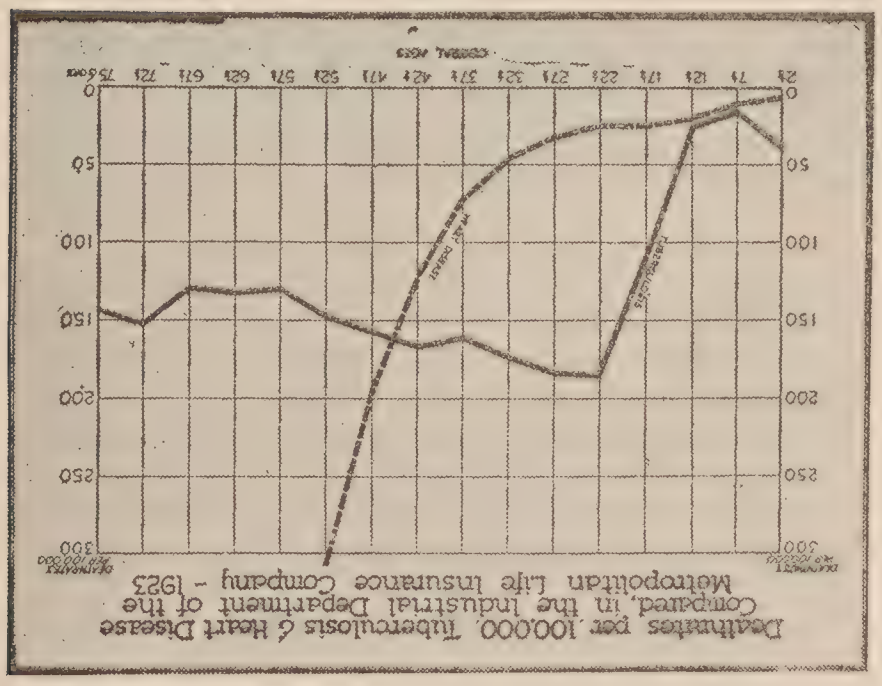
Figure 1



ed with coronary artery disease, and is as stated by the late Sir James MacKenzie, "an expression of cardiac exhaustion and also an expression of a susceptible nervous system."

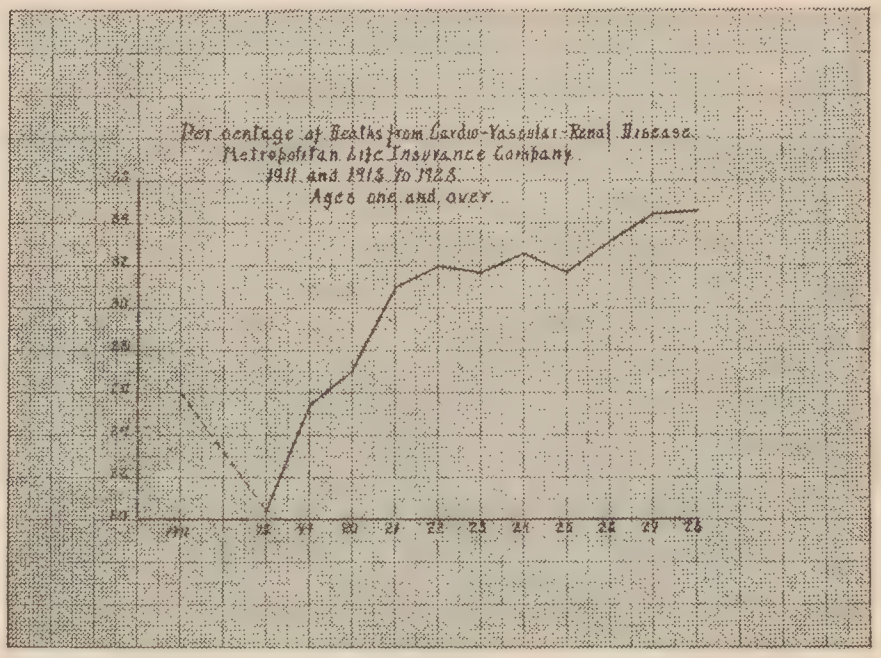
The first chart, Figure 1, gives the

Figure 2


Deathrates per 100,000. Tuberculosis & Heart Disease
Compared, in the Industrial Department of the
Metropolitan Life Insurance Company - 1923

death rate for heart disease per 100,000 in the United States Registration area. This is a composite for all ages, and shows a definitely advancing rate. The temporary fall in rate for the years immediately following the influenza epidemic is probably explain-

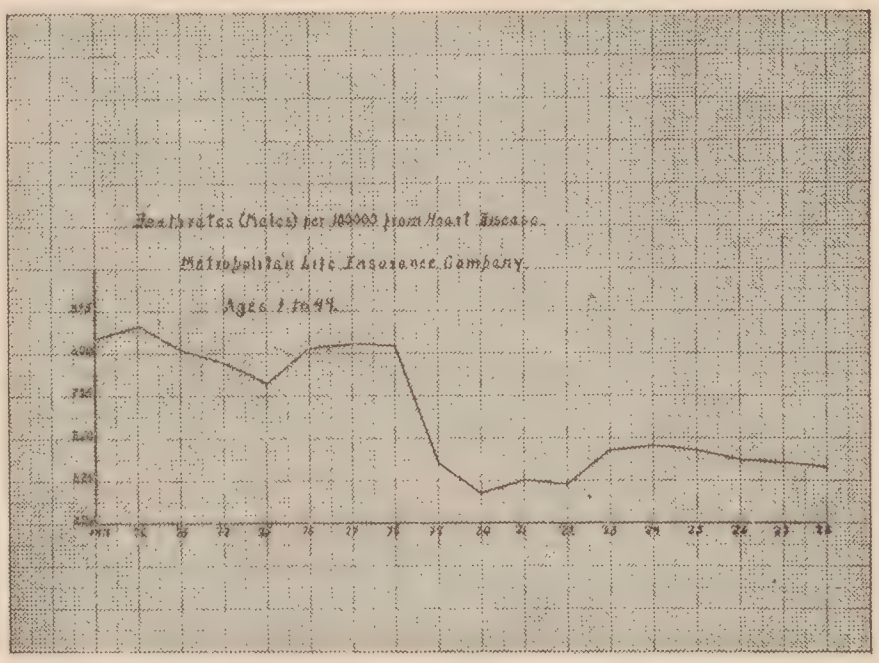
Figure 3


Per centage of Deaths from Cardio-Vascular-Renal Disease
Metropolitan Life Insurance Company
1911 and 1913 to 1923.
Ages one and over.

ed on the basis that many people who would have died in those years of heart disease were taken by the influenza.

Figure 2 is a comparison of the death rates in tuberculosis and in heart disease. In the earlier decades of life, tuberculosis takes the larger toll,

Figure 4



but after 45, the heart rate advances tremendously.

In Figure 3 there is grouped together the deaths from heart disease, Brights disease and cerebral hemorrhage, and charted the percentage of

deaths from these causes out of the total deaths exclusive of those due to external violent causes. Here again we find a steadily, though slowly, increasing death rate.

Let us next analyze these rates according to age groups during the years 1911 to 1928 inclusive. Figure 4 shows the rate in the age group from 1 to 44 inclusive and reveals a gradual definite decline. Figure 5 shows the age group from 45 to 64 inclusive, and Figure 6 from the age 65 on. These last reveal a beginning increase before the influenza epidenmic of 1918, then a marked fall for the three or four years following, probably for the reason already mentioned. Since 1923 there has been a steadily advancing rate.

Figure 5

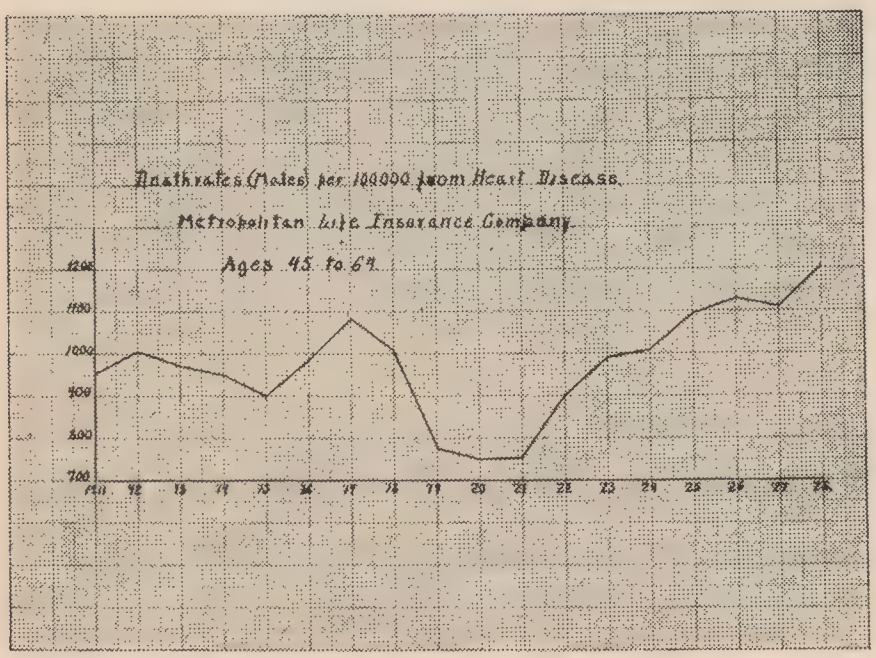
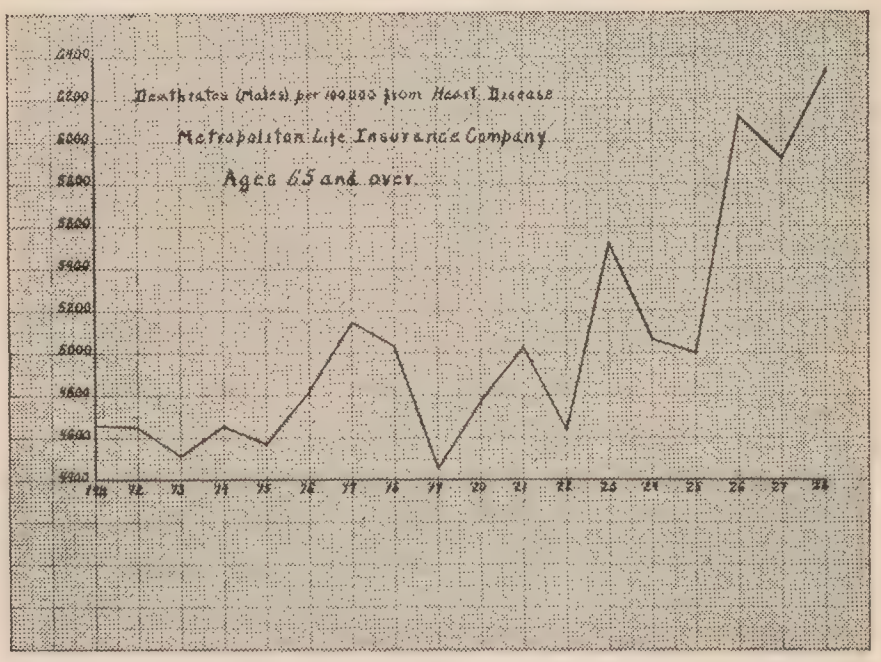


Figure 6



This shows us graphically then the fact stated in a recent number of the statistical bulletin "That the rise in death rate applies only to higher age groups and that distinct improvement has taken place in recent years, in childhood, adolescence and early adult life." It is to be remembered, however, that while the highest mortality from heart disease is after the age of 45, the lesion itself is often acquired in childhood.

What can and is being done to still futher lessen the death rate in the earlier decades and to bring into better control the definitely advancing rate in the group of 45 years and over? The concerted campaign against heart disease is still in its formative stage, and the answer to the problem must be somewhat guarded. It must be attacked from two well co-ordinated viewpoints, that of the individual, and that of the community as a whole.

As it concerns the individual, the problem is chiefly one of personal hygiene. Children must be protected against the infections which cause heart disease. Among young adults, the better control of syphilis will help considerably. Saner and more temperate living on the part of all, but especially those in middle life, with due regard to rest and exercise and the avoidance of physical, emotional and nervous excesses, will result in stronger bodies, better able to withstand heart impairments. It is a recognized fact that angina pectoris is

"more prevalent in those classes of society who are subject to excessive mental wear and tear, whether from overwork, worry or anxiety, and is more common in those who have been subjected to long continued physical overstrain." With our recent tendency to speed up everything that we do, whether it be in work or play, we must realize that there is a limit to the capacity of our nervous and cardiovascular systems, and learn to keep within this limit.

One of the most important of all personal efforts is the development of the habit of periodic health examinations, and this should apply to children as well as adults. It is a striking fact that most persons who have heart disease have discovered it in some accidental way. Often the history or the ordinary means of examination will reveal to the physician an early lesion which, properly cared for, will not become serious. In more obscure or difficult cases, valuable diagnostic or prognostic information is obtainable by means of the electrocardiograph

Having obtained information regarding his heart, it is then up to the individual to live within the limits placed upon him by his heart, and to heed its warnings of over-work as manifested by shortness of breath, palpitation, pain in the heart region, or swelling of the feet and ankles.

The contribution which the community can make to our problem is likewise many sided. Probably it should be attacked in much the same way as has the campaign against tuberculosis. An educational program is very important. The public schools are in an admirable position to discover the large group of children who are disposed to heart disease. The organized health agencies of the various states and cities must, and are, providing heart clinics. Sanatoria and convalescent homes are equally important.

Another very important phase is the co-operation of business and industrial executives. Very many heart patients may engage in useful, productive, self-sustaining employment if their employers reserve for them the less strenuous, though necessary tasks.

In conclusion then, the situation may be summarized as follows:

1. Heart disease is first in the causes of death and disability, exacting a tremendous yearly toll.

2. The death rate in persons below the age of 45 is slowly decreasing, but still remains much too high.

3. The rate for those above 45 is showing a surprising increase.

4. The risk of dying of heart disease is now greater than it used to be.

5. The situation calls for an awakening of the individual and public consciousness to the problem, the development of the habit of periodic health examinations, a general slowing up of our strenuous mode of living, and the further promotion of a general anti-heart disease campaign similar to that now in effect for tuberculosis.

I am indebted to the statistical department of the Metropolitan Life Insurance Company for the statistics here presented.

Ground Water of Eastern and Central Montana

By Eugene S. Perry

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EASTERN and Central Montana is a high plains region, about 250 miles across, cut by river valleys. "Bad-land" topography has been developed in many places. Rainfall is between 10 and 20 inches per year and consequently much of the region is nearly barren. The larger part of the land is productive, providing water can be secured, and practically all of the area is suitable for grazing if water can be obtained for the stock. The water supply is therefore a serious problem.

The ground water supply of eastern and central Montana can readily be divided into two rather different types, (1) shallow ground water which circulates thru the surface soils, sands, and gravels, and (2) deep ground water which circulates thru porous sandstone beds and which occurs under artesian conditions. The shallow ground water is of greater importance to cities and towns because it ranks next to river water as a source of municipal water supply. The deep ground water is of great importance to ranchers and stockmen because in so many places it furnishes a source of supply in regions of scanty rainfall and intermittent streams.

Shallow Ground Water

Shallow ground water is present in the favorably situated soils, sands, river gravels and glacial drift. Most important of such favorable places in Montana are present-day stream and river valleys, and abandoned valleys now filled with glacial drift. In a few localities, soils and ancient gravels situated on uplands contain potable water. The rivers are the source of much of the water which percolates into the valley fill. However, some of the shallow gravel water seems to have a different source, as may be inferred from the composition of the water which does not correspond to that of the river water. Particularly is this true in the northern part of the state.

The river valleys of eastern Montana have had a varied history involving successive periods of peneplanation and rejuvenation, resulting in several gravel-covered terraces and flood plains. In the region of glaciation, valleys are filled with drift and much of the post-glacial drainage is along different lines than was the pre-glacial drainage. The flood plains of the Milk and Yellowstone rivers in many places are from three to five miles wide and are composed of 50 to 150 feet of clay, sand and gravel. Three transcontinental railroads pass along these two valleys (N. P., G.N., and C.M. & St.P.) and some of the best farm land of Montana is situated in them. Consequently these valleys are quite thickly settled. The great advantage of getting an abundance of good water requiring little treatment and at depths of from 25 to 100 feet can readily be appreciated. River gravels are the source of city water supply for more than a dozen towns, including Havre, Malta, Glasgow, and Helena.

Deep Ground Water

The term deep ground water in this paper may be defined as that water which has worked its way into porous beds, chiefly sandstones, and which has traveled thru the porous beds below impervious beds to localities distant from the outcrop. Although it has its origin in shallow ground water, it soon becomes entirely distinct and independent of it. This deep ground water

may take up more mineral matter, and when it again appears at the surface it is very different in its characteristics. If the dip of the strata and the slope of the land are suitable, hydrostatic head (or water pressure) may be developed. Two hundred and fifty pounds pressure has been measured in one Montana well, and in some towns including Lewistown nad Terry, the pressure is above 25 pounds.

More than ten different geological formations carry water in eastern and central Montana. Beginning with the youngest and ending with the oldest (lowermost) these formations are as follows: The Fort Union formation, the Lance formation, the Judith River formation, The Eagle formation, the Kootenai formation, the Chugwater formation, and the Quadrant formation. In no one locality do all of these produce water. In fact, in most localities only one formation may produce, but occasionally two or even three are productive. This is partly because all the formations are not everywhere present, and partly because some of the sediments in Montana change rapidly in their lithologic characteristics from place to place. Consequently Montana may be divided into several small artesian provinces in accordance with the geological formations which produce water. These will now be described separately.

Water From the Fort Union Formation

The Fort Union beds, said to be of Tertiary age but of a transitional character between typical Tertiary and typical Cretaceous, cover an area of 20 to 30 thousand square miles in Eastern Montana, or about one-seventh of the total area of the state. This formation which is the principal coal-bearing formation of Montana and Wyoming and which in places has beds of lignite coal over 25 feet thick, is composed of about 1,000 feet of interbedded shales and sandstone, the sandstones being abundant, thick, and coarse-grained. The Fort Union formation occupies the areas of higher elevation except in the extreme eastern part of the state, and all of the major streams have either cut entirely through it or else deeply into it. Much of the upland is of the nature of a rolling plateau cut by stream valleys. The beds are practicallly flat-lying. A very gentle regional dip carries the beds downward to the east, although there are local variations of dip.

Much of the rainfall on the upland area works downward into the sandstone and coal beds, and in many places, especially near valleys, it then moves more or less horizontally toward the valleys. Many seepage springs occur along hill sides where sandstone and coal beds crop out. Away from the valleys on the uplands, drilled wells have encountered an abundance of water almost everywhere, at depths from 50 to 300 feet. The water has to be pumped, nad windmills and gasoline engines are used. The quality of the water is nearly always satisfactory.

Water From the Lance Formation

The Lance formation of Upper Cretaceous age, like the overlying Fort Union is a series of interbedded shales and sandstone 800 to 1000 feet thick. These beds are, however, more sandy and the colors are described as somber, being a dull greenish yellow to ocher. They contain remains of dinosaurs and land plants. In places the sandstone members contain thin resistant beds and upon weathering develop odd toadstool-shaped pinacles. "Bad-land" topography is common. The area of outcrop forms an irregular band five to fifty miles wide passing across the state in a north-south direction about 100 miles west of the eastern boundary. The structure is similar to that of the Fort Union formation.

The Lance furnishes water for hundreds of flowing wells, and in Powder River County alone more than 150 of these wells occur. In areas of artesian water the top of the Lance is commonly at about the same elevation as the drainage and the Fort Union occurs in the adjoining hill slopes so as to form the surrounding uplands from 300 to 500 feet above the valleys. Pressure at the mouth of the wells is from 1 to 30 pounds, not enough to lift water far above the valley floor. Consequently flowing wells are confined to the valley floors which are relatively narrow. This rather unusual distribution of flowing wells along the larger river valleys has lead certain geologists to designate them as "the narrow valley type" of wells. Positions of water sands are not constant and there may be three or four producing horizons in one well, or none at all in other cases.

In places it is difficult to demonstrate the particular conditions responsible for the flow, because the geological structure and the slope of land does not always appear favorable. Although the writer believes that commonly accepted conditions required for artesian wells are responsible for these wells, modifications undoubtedly influence the pahtway of the water. Chief among these modifications is the occurrence of lenticular sands which may even be of the "shoe string" type such as are deposited along river channels in continental deposits.

The volume of flow of the Lance wells varies from less than one gallon per minute to more than fifty, ten to twenty gallons being an average. The quality of the water is good and the taste is pleasant, and although the mineral content is considerable its effect is to soften the water. During the long, cold winters of eastern Montana, the continuous flow of artesian water, which is relatively much warmer than the icy river water, is excellent for stock and often one hears paradoxical stories about cattle swimming a river to get a drink of water from these wells. The stock "acquire" a taste for the mineralized artesian water, and also prefer it because it is warmer in winter.

Judith River and Eagle Water

The Judith River and Eagle formations, separated by the 400 feet of Claggett shale, are described together because the geographic distribution of wells in both is about the same, and the two together may be considered to form a small artesian province. Both formations are of upper Cretaceous age. They differ in character from place to place, becoming more shaley or more sandy, and although both are dominantly sandstone, they are quite dissimilar from each other.

The younger, Judith River, formation which underlies 1000 feet of blue-gray gumbo clay-shale of the Bearpaw (Pierre) formation, is a series of sandstones and shales 400 to 500 feet thick. It is both continental and marine in origin and in some places, as near Havre, oyster beds and coal seams alternate. A detailed section taken at any point is of little value since another section made at a distance of only a mile or two would give a quite different sequence of the alternating strata. Color varies from light gray and yellowish to olive-drab. The outcrop of the Judith River formation is irregularly distributed north and south, across the central part of the state, frequently formnig concentric bands about areas of uplift. The area of outcrop of the Judith River formation is along the Rocky Mountain front and near the mountains the beds are bent into folds and are cut by normal faults. A regional dip to the east finally carries the formation beneath younger beds.

Water can enter the Judith River formation at its outcrop on the flanks of several of the large mountainous uplifts, such as the Big Snowy and Little Rocky mountains, at elevations much greater than the land surface in the plains to the east of these mountains. Such water can work down the dip of the strata, even tho the sandstones are shaley and of low porosity. In the valleys of the Missouri, Musselshell and Milk Rivers, wells penetrate the Judith River formation at depths of 200 to 800 feet, and the formation produces flowing water in volumes from 1 to 25 gallons per minute. The composition of the water is alkaline, and the taste is often so strong that travelers refuse to drink it.

The Eagle formation is typically a cliff-forming sandstone, from 250 to 300 feet thick, and medium to coarse-grained. Shale beds appear in some localities especially in the upper part of the formation. The outcrop is a band roughly parallel to the Judith River formation but nearer to the centers of the uplift. Away from the areas of steep folding the Eagle is found 400 feet below the Judith River, and when tapped by wells it produces flowing water where surface elevations are low enough, for example, in the bottoms of the larger rivers. In practice the well drillers do not know whether their water comes from the Eagle or Judith River formation, and since records of formations passed through are rarely kept (in many cases no record is kept of the depth at which water is found) it is difficult to distinguish between Judith River and Eagle wells. Typical Eagle water tends to have less mineral matter and to have a more pleasant taste than the Judith River water.

Kootenai Water

The Kootenai formation, of Lower Cretaceous age, equivalent in a general way to the Dakota Sandstone formation, is an alternating series of red to gray continental sandstones and shales about 500 feet thick. It crops out in many places in central Montana, on the flanks of mountainous uplifts for the most part. Its sandstones are more porous than those described thus far, because smallre amounts of clay minerals accompany the sand grains. Streams flowing across the outcrops of the Kootenai formation may be completely absorbed, as for example, Sand Coulee, south of Great Falls. (Much of the water of Sand Coulee later appears near Great Falls at Giant Springs, the volume of which is closely estimated at 600 second feet or more.) Structurally the formation rises onto the flanks of the several mountain folds, and away from the uplifts it dips downward under the lowland areas.

The greater porosity of the Kootenai sands and the higher outcrops of the formation on the mountain flanks result in more rapid migration of water and greater pressures. Because of its stratigraphic position and the position of the erosion surface in Montana, the Kootenai is usually found at depths of over 1,000 feet. Only in the neighborhood of Lewistown have wells been put down into the Kootenai for water. Elsewhere oil and gas test wells have penetrated the formation, and in the drainage of the Musselshell river, in the regions of the Bowdoin and the Porcupine Domes, and on the flanks of the Big Horn mountains scores of flowing water wells have been developed. Volumes range from 20 to 500 gallons per minute and occasional wells have had volumes estimated at several thousand barrels per day. A well in the valley of the Musselshell River showed a closed pressure of 250

pounds, and was estimated to have flowed over 1,500 gallons per minute.

Chugwater Formation

The Chugwater formation of Triassic age, sometimes called the red bed formation, is present in a small part of south-central Montana. Altho its sandstones are porous, they are of little importance in Montana as water horizons because of their limited extent.

Quadrant Formation

The largest flowing wells in Montana, perhaps in the United States, get their water supply from the Quadrant formation of Pennsylvania age. Also, the Quadrant is the oldest and lowermost formation which has typical artesian water. Because of its depth it is seldom reached by drill holes and only a few wells penetrate the formation.

A well in Carbon County illustrates Quadrant water flows. East of Bridger an oil test well was being sunk on a sharp anticlinal fold. When the drill passed into the Quadrant formation, water spurted 10 to 20 feet above the top of the fourteen inch casing pipe. Fittings were not at hand to close off the flow and in a couple of days a large gully had developed, leading away from the well. The gully advanced so fast under the derrick foundations that in order to save the drill rig and machinery everything had to be moved in great haste. Within a month a gully 30 feet deep and 100 feet or more wide had developed. The volume from this well was estimated at 1500 to 2500 gallons per minute.

Some Quadrant water contains hydrogen sulphide, but this soon escapes into the air and the water is then satisfactory for domestic and stock purposes.

Summary

Parts of eastern and central Montana have an abundance of pumping wells obtaining good water at depths less than 100 feet. River and glacial gravel and the Fort Union formation are foremost in such water production. The Lance formation furnishes good water to hundreds of small flowing wells along narrow valleys of the large rivers in southeastern Montana. The Judith River and Eagle formations furnish water, some of which is alkaline, to small flowing wells in north central Montana. The Kootenai formation is a prolific producer of excellent water throughout central Montana, and flowing wells of large size often are obtained. The largest flowing wells in the State obtain their water from the Quadrant formation. Between these several areas of water wells are broad areas underlain by great thicknesses of clay shale (1000 to 2000 feet thick) where drill holes obtain little or no water, or else water containing a large amount of sodium sulphate and unfit even for stock use.

The study of ground water occurrence in eastern and central Montana leads to the conclusions (1) that several pronounced water producing horizons exist and (2) that because of structural conditions, in which mountain uplift has occurred locally, hydrostatic heads have been built up in various places. The Montana Bureau of Mines and Geology is of the opinion that flowing water wells can be obtained in localities where at present wells have not been drilled and where surface water is of poor quality.

Tests on Gas Grain Treater for the Control of Smut[1]

JESS KIENHOLZ AND W. K. SMITH
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FOR many years covered smuts of cereals have caused heavy losses in the Pacific Northwest, as well as in other parts of North America and in other countries. Efforts have been made in two main directions to eliminate or reduce these losses (a) by the production through breeding and selection of resistant or immune varieties and (b) by the introduction of convenient and effective methods of seed treatment.

Some advance has been made in the intorduction to cultivation of varieties which in addition to smut resistance have other desirable agronomic qualities. Progress in this work is slow because of the presence of numerous physiologic forms of the fungi causing cereal smuts so that seed treatment of susceptible or partially susceptible varieties will have to be carried out for some time. Further, under the systems of farming which prevail in this area, resistant varieties in a short time become contaminated with mixtures of susceptible sorts. The farmer, therefore, looks for a method of seed treatment which will be effective and will reduce the labor entailed to a minimum. The formaldehyde dip has been used extensively in the control of smuts but it necessitates much handling of grain and frequently there is loss from direct injury to the seed, from freezing, sprouting and uneven sowing.

In the standard formaldehyde solution, the active principle which kills the smut spores is, of course, formaldehyde gas. It seems reasonable to expect that, since formaldehyde gas is given off on heating paraformaldehyde powder, the administration of the gas from this source would be more convenient and more efficient.

For a number of years, an apparatus, a "Gas Grain Pickler," designed to put this idea into practice, has been on the market in Canada in the provinces of Alberta and Saskatchewan. It was tested (1, 2) in Saskatchewan for effectiveness in the control of stinking smut of wheat in 1921 and 1922, while a thorough test was carried out in 1926 (3). It was found that the control of bunt was unsatisfactory, while there was evidence of slight seed injury. In the "Gas Grain Pickler" air is forced through the grain only after the gas has been liberated, while in an "Improved Gas Grain Treater" appearing recently in the United States, the gas as it is liberated is distributed through the grain under pressure, and on this account may be more evenly dispersed. Numerous inquiries have been received recently by the State College of Washington concerning this 1928 model. Tests were made in 1929 by the Departments of Plant Pathology and Agronomy to determine the value of the above-mentioned modification.

Apparatus and Its Operation

The essential parts of the machine are the gas generator, pump and conducting pipe. The apparatus is set up and the treating pipe is inserted in the grain. A measured quantity of paraformaldehyde is placed in the generator cup which is screwed into position. Gas is generated by heating this cup from below by the burning of a "liquid heat"

[1]Presented at the annual meeting of the Northwest Scientific Association, Dec. 27-28, 1929, Spokane, Washington. Published as Scientific Paper No. 163, College of Agriculture and Experiment Station.

[1]Gussow, H. T. Interim report of Dominion Botanist of Dominion of Canada, pp. 68-69. 1922.

[2]Report for 1922 of Dominion Botanist of Dominion of Canada. p. 51. 1923.

[3]Report for 1926 of Dominion Botanist of Dominion of Canada. pp. 116-118. 1927.

preparation. Pumping is begun as soon as the liquid is ignited, and a steady pressure is maintained until a few minutes after the fire has burned out.

Tests Made and Results Obtained

In order to determine the effect of this method of treatment on the germination of wheat, an experiment was carried out in the greenhouse in the spring of 1929. A 120-pound sack of Jenkin wheat, which is a smut susceptible but widely grown spring variety of *Triticum compactum*, was treated by inserting the pipe through the end and into the center of the sack, and fumigating in the manner described above. By means of a tube of convenient size, samples were drawn from the central portion and from the periphery of the sack. For comparison, samples were also taken from Jenkin wheat which had been treated at the same time by the standard formaldehyde method. Three series of samples were drawn. These were taken at intervals of one hour, 24 hours, and four days respectively after treatment. Two hundred seeds were counted from each sample and planted in moist soil in flats in the greenhouse. Counts were made after the control seedlings were well above ground. The test was repeated in May and the average results of the two tests are recorded in Table 1.

Table 1. Effect of the "Gas Grain Treater" on the germination of seeds of Jenkin wheat sown in moist soil in the greenhouse.

Treatment	Percentage germination in samples drawn at intervals after treatment.		
	1 hr.	24 hrs.	4 days
Check	75	87	89
Periphery of sack	76	75	88
Central portion	62	34	31
Standard formaldehyde	53	60	58

It is apparent from Table 1 that the seeds in the central portion of the sack were injured severely when the grain was allowed to stand 24 hours or more after treatment. In farm practice seeding generally would not be done directly after treatment. Towards the outside of the sack, however, the grain gave a percentage germination just as high as the untreated seed and higher than the standard formaldehyde dip. It is possible that the zone of injury was not extensive and that, taking the sack as a whole, the impairment of vitality was slight.

In order to determine the effect of this method of grain disinfection on the amount of stinking smut in a crop grown from smutted seeds, a test was carried out in the field during the growing season of 1929. The same amount of wheat as in the previous experiment, 120 pounds, was inoculated with the spores of *Tilletia tritici* at the rate of approximately 10 ounces per bushel. Samples were drawn at intervals after treatment as in the previous experiment and from each sample three replicates each consisting of 100 seeds were sown in the field, the seeds being placed approximately two inches apart. The data are summarized in Table 2.

The data on percentage stand in Table 2 from seeds sown in the field are in close agreement with the data shown in Table 1. The results obtained in the field confirm the conclusions drawn from tests in the greenhouse, viz., that, although the treatment may be harmful to the grain in the cen-

(Continued on page 114)

Table 2. Effect of the "Gas Grain Treater" on the stand and the amount of bunt in Jenkin wheat from seeds which had been inoculated with the spores of *T. tritici*.

Treatment	Percentage bunt from samples drawn at intervals after treatment			Percentage stand from samples drawn at intervals after treatment		
	1 hr.	24 hrs.	4 days	1 hr.	24 hrs.	4 days
Check	62	55	43	78	86	89
Periphery of sack	69	64	42	86	83	83
Central portion	11	24	2.4	69	46	32
Standard formaldehyde	0	3.7	1.5	76	54	51

David Thompson-Land Geographer of the Northwest

By William S. Lewis
Spokane, Washington

DAVID THOMPSON has been declared to be the greatest land geographer that the Anglo-Saxon race has ever produced. Like many, who rise to great accomplishment, he was of most humble origin. He was born in the parish of St. John the Evangelist, London, on April 30, 1770, of poor Welsh parentage. Left an orphan at an early age he was recommended to and accepted by the Governors of the Grey Coat School of London. In December, 1783, in response to a request by the Hudson's Bay Company for a couple of intelligent apprentices, he was one of two recommended by the head of the school to the Hudson's Bay Company for service at their posts in America. He was apprenticed in their service for seven years. May 20, 1784, at the age of 14 years, he embarked for Fort Churchill, the most northernly post on the west side of Hudson's Bay, where he began his career as a fur trader. For several years he followed the routine duties of the average apprentice clerk of the Great Company in lonely and remote trading posts.

At this time the Colonial Office was urging the Hudson's Bay Company to survey the vast territory over which it exercised sway. Eventually, to satisfy the insistent demand of the Government, the Company engaged one Phillip Turnor as astronomer and surveyor—a man of sound theoretical training, one of the compilers of the *Nautical Almanac* and, since 1776, qualified by a wide practical experience from numerous surveys throughout the Hudson's Bay district. David Thompson met Phillip Turnor at Cumberland House during the winter of 1790. He became the eager student and constant companion of Turnor, who encouraged his ambition and corrected some of the deficiencies of Thompson's education for the work he was to undertake. When David Thompson returned to York Factory in the spring, it was as a man with his mind made up as to his future career. Thereafter David Thompson and his beloved instruments were inseparable companions by day and night. He was an object of wonder to his French-Canadian and Indian followers as, armed with his transit, telescope and sextant, he took observations of the sun, moon, and stars, and sought to definitely determine and record the position of lakes, rivers and mountains for record on the map which was to be his life's work. To their superstitious minds his activities with these instruments suggested the idea that he was in communication with the powers not of this world and they conferred on him the title which he afterwards bore among them, Koo-Koo-Sint, "The man who looks at the stars." Their appreciation of his greatness and their awe of his knowledge is exemplified in the statement of the war chief, Kootenae Appee, who said, "What can we do with this man? Our women cannot even mend a pair of shoes but he sees them," alluding to the belief that Thompson, with his telescope, could see from a distance right through the tepee covering and observe and hear what was being said and done by those inside.

For the next six years David Thompson pursued his surveys whenever opportunity offered and time permitted in his trading employment. By 1796, however, pressure on the Hudson's Bay Company from the Colonial Office had, apparently, subsided and Thompson received a curt order from his superiors directing him to cease his surveys and explorations and to devote his time ex-

A new and correct Map of the Countries of North America situated between the parallels
Superior and Hudson's Bay, quite across the Continent to the Pacific Ocean, finished in 18

and 60 degrees of north latitude; and extending in longitude from the east side of Lake
hompson.

FIGURE 1

A new and correct Map of the Countries of North America situated between the parallels of 45 degrees and 60 degrees of north latitude; and extending in longitude from the east side of Lake Superior and Hudson's Bay, quite across the Continent to the Pacific Ocean, finished in 1812, by David Thompson.

clusively to the fur trade. On the 28th of May, 1797, Thompson left the Company's employ and traveled from his post on Reindeer Lake to Grand Portage at the west end of Lake Superior—the headquarters of the North-Westerners—to offer his services to that rival concern. He received a warm welcome there and soon met such great adventurous explorers of the Company as Sir Alexander McKenzie, Roderick McKenzie, his cousin, and Simon Fraser, who was later to win distinction as the discoverer of Fraser river. David Thompson was promptly engaged as an astronomer and surveyor by the North-Westerners. In their employ he proceeded to finish his great work, and chart on his map most of the territory from the east side of the Rocky Mountains westward to the Cascades.

David Thompson's map (Fig. 1) was the result of 22 years single-handed effort in discovering, surveying and platting the rivers, lakes, hills and mountains on this vast expanse of virgin country. Throughout his life he was inspired by a restless impulse to push forward the exploration and mapping of the west until not a corner of it was unknown. Impeded at all times by the duties and responsibilities of his trading employment, the indifference and lack of support, if not opposition of his employers, and the resistance of hostile Indians, he yet traced to their sources and mapped all the great rivers of the north part of the continent, on both sides of the mountains, within the limits of his map. The sources of several of these great rivers and even the contours of the west shores of Lake Superior were first examined, surveyed and laid down on a map by him. He was the first white man to discover and explore the upper Columbia valley or watershed, and he was the first white man to traverse that river from its source to the sea. In hardships encountered and overcome, and in sheer length of his journeys alone, few western explorers have equalled the record of Koo-Koo-Sint, "the star gazer", for he traveled in all—on foot, by horseback, or canoe—not less than fifty thousand miles.

Prior to David Thompson's work these parts of North America had long been a desideratum on geography. Thompson's explorations and surveys were finished in 1811 and his map finished in 1812. In the developments of the next seventy-five years it may be said that his work was not materially improved upon. The faithful, unvarying exactitude with which he originally surveyed, recorded in his notes and mapped this vast area—from Hudson's Bay and Lake Superior west to the Cascade Mountains—many parts of which had never before been explored, has excited the surprise and admiration of engineers on both sides of the International Boundary. Members of the Canadian Geological Survey, who, with infinitely better instruments, traced part of his progress nearly a century later, have testified as to the correctness and fidelity of his original surveys. Some remote districts mapped by David Thompson such as much of the "muskeg" country, have never been surveyed since his day and small portions of his work therefore still appear on published maps of Canada.

Most of the area of the province of Alberta and much of British Columbia, northwestern Montana, northwestern Idaho, and eastern Washington, were familiar to him through personal travel, observation and surveys made by him and this region was dotted with his trading posts. Kootenay House, (B. C.); Salish or Flathead House (Montana); Kullyspell House (Idaho); Spokane House (Washington) — the sites of the first white men's establishments in this region—were all founded by David Thompson and his men.

When the Hunt overland party of the Astor fur expedition were in the vicinity of the Blue Mountains, as related by Washington Irving in his *Astoria,* the Americans expressed some surprise and chagrin that the Indians they encountered did not show more interest and curiosity regarding them as the first white men in their vicinity. On inquiring of the Indians, the Astorians were told that the Indians had already met some "great white men" at the headwaters of the Columbia river, to-wit: "Jacquean and Ke-koosh" whom we will now identify as David Thompson and his Canadian-French assistant, Jacco Finley. The latter's Christian name is preserved in Jacco Creek and Jacco station in Montana, and his family name is borne by the Finley river, the great northern branch of the Peace river in British Columbia.

An examination of the details of Thompson's map illustrates how well in the brief time and with the meager facilities at his command he observed, and how carefully he surveyed and recorded on his map the location, contours and typographical details of mountain range, lake and stream. In this connection the writer calls special attention to the contours of Lake Pend O'Reille as outlined in the accompanying reproduction of Thompson's map.

The necessity for brevity in this article precludes much further comment in biographical or geographical detail. David Thompson's map and accomplishments failed to secure the interest, attention and support of his contemporaries. He died in poverty at Longueuil, near Montreal, Canada, February 10, 1857, and was buried in Mount Royal cemetery, without even a stone to mark his grave. For over fifty years his achievements were comparatively unknown, and his accomplishments and deserved fame practically unrecognized. He was one of the builders of the empire and only circumstances of weather and hostile Indians prevented him in 1800 to 1810 from preceding, single handed, both Lewis and Clark and the Astorians in the exploration and possession of the Columbia river region.

David Thompson's name is preserved in Thompson Falls of the Clark's Fork river and in Thompson's Creek and the town of Thompson Falls in the state of Montana; and in Thompson's River, a tributary of the Fraser River in British Columbia (named in his honor by his friend and associate, Simon Fraser), and in the town of Thompson, above Lytton, B.C. To Mr. J. B. Tyrell of the Canadian Geological Survey, to whose attention the David Thompson's map and existing surveys and records were brought in the course of his professional labors, and who in several instances checked their accuracy, is mainly due the credit for bringing David Thompson's accomplishments to the attention of present day engineers, geographers and historical students. Tyrell's *"David Thompson's Narrative,"* 1915, magnificiently published by the Champlain Society of Canada and sold at $5.00 a copy, rapidly became one of the rarest and highest priced books of Northwest Americana, and is now selling around $150.00 a copy. There are short chapters on David Thompson in Bryce's *History of the Hudson's Bay Company;* Laut's *Conquest of the Greater Northwest;* Wallace's *By Star and Compass,* and considerable material in Coue's *New Light on the Early History of the Northwest,* and Professor Cochrane's *David Thompson,* to which the writer is indebted for much of the data here presented. An article by Mr. L. J. Burpee, with particular reference to Thompson's Map, appears in the *Canadian Historical Review,* Vol. IV. p. 105 (1923). His original manuscript notes, in many volumes, are in the Dominion Archives.

The Origin of Extraterritoriality in China

By Earl H. Pritchard
State College of Washington

EXTRATERRITORIALITY has been defined as "the right of a foreign government to use its own courts and laws in the trial of cases involving its subjects"[1] in a foreign country.

In view of the recent demand made by the Nationalists Government upon all powers exescising extraterritorial jurisdiction in China that such rights be abolished, it is fitting to refresh our memories upon the circumstances leading to its establishment.[2]

In a recently published doctoral dissertation entitled: *Extraterritoriality: Its Rise and Its Decline*, Dr. Shih Shun Liu, after pointing out that the system of extraterritoriality arose in Turkey and the Levant because of "the union of Mohammendan law and religion, the desire of Islam to invite foreign commerce, and, above all, the existence of long-established custom and usage" which favored the exercise of a personal law in the case of foreigners,[3] goes on to say:

> A different story, however, must be told of the establishment of extraterritoriality in the Far East. There, religious differences did not necessitate a special jurisdiction, the motive of foreign intercourse was by no means persistent, and the force of custom was distinctly averse to the assertion of judicial competence by foreign magistrates.[4]

He states further that "the differences of civilization between the Orient and the Occident give no clue to the explanation" of the origin of extraterritoriality in China, but that we must turn to "seek an explanation in the alleged deficiency of the Oriental legal systems."[5]

The statements of Dr. Liu are based upon facts which are individually unimpeachable, but which either through lack of information or intentional omission, are so incomplete as to impugn the soundness of his conclusions. I shall take a position which to some extent contradicts that of Dr. Liu, and by new facts at my disposal attempt to show that at the basis of the origin of extraterritoriality in China lay (1) the differences between Oriental and Occidental civilization, especially as represented in municipal laws and legal practices, international usages, and attitudes toward individual and personal responsibility for acts of others; (2) the necessity for the continuance and expansion of trade and commerce; and (3) the existence, through intercourse with the West, of precedent and custom of such a character that the demand for complete extraterritorial jurisdiction was not unjustified. However, if these factors lay at the bottom of the origin of extraterritoriality, its legal and actual existence was brought about only through the force of arms and the treaties following the Opium War.

Let us begin by examining the differences in civilizations as represented in a number of incidents involving relationships between Chinese and foreigners. Two cases of criminal jurisdiction, the *Lady Hughes* affair, and the *Neptune* affair, will illustrate the incompatibility of laws and judicial practices, and at the same time show the impossibility of the West acquiescing in the Chinese Doctrine of respon-

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[1] Raymond L. Buell, *International Relations* (New York, 1924), p. 461.

[2] *Far Eastern Review*, September, 1929, pp. 386-87.

[3] Shih Shun Liu, *Extraterritoriality; Its Rise and Its Decline* (Columbia University, 1925), p. 76.

[4] *Ibid.*, p. 76.

[5] *Ibid.*, p. 84.

sibility which lay at the bottom of their whole legal and political system.

The *Lady Hughes* was a ship belonging to a private Indian merchant who was carrying on trade at Canton under license of the East India Company. On the 24th of November 1784, a gunner of the ship while firing a salute accidentally injured two minor mandarines so badly that they died the next day. The Chinese officials, acting through their merchant representatives, demanded that the Chairman of the British merchants surrender the gunner for trial. The Chairman, who was chief of the Select Committee having charge of the affairs of the East India Company, replied that he had no control over persons on ships not belonging to the Company, and further that the gunner had absconded. The Chinese, paying no attention to the chairman's lack of jurisdiction, repeated their demand for the surrender of the gunner or someone to take his place.[6]

The case thus far reveals three important points. First, that the killing was accidental; second, that the chief of the English merchants was held responsible for exercising jurisdiction over all theE nglish at Canton; and third, that someone, whether the actual perpetrator of the act or not, must be surrendered for trial. This last contention was totally untenable according to Western standards, but was quite customary in Chinese practice, growing directly out of their doctrine of responsibility. This amazing doctrine held every Chinese personally responsible for anything which might happen no matter how remotely related to him. If a theft was committed in a village, the village was held responsible; if a son committed an offense the father was held responsible; if a murder was committed in a town the magistrate was held responsible, and must secure the arrest, prosecution, and execution of the guilty man. Failure to bring someone to trial meant expulsion from office and punishment. A life had been lost; to avenge it a life must be taken. The result was that no offense went unpunished.[7] Under these circumstances we can readily see why foreigners hesitated before surrendering themselves to the Chinese for trial.

To return to the case under consideration, when the gunner or a substitute was not surrendered, the chief supercargo of the ship *Lady Hughes,* who happened to be abroad in Canton, was seized and held as a hostage until the gunner should be surrendered. When this did not bring about the desired results, trade was stopped, and communication between the shore factories and the ships was cut off. The threats and demands of the officials increased, and finally to save themselves and the imprisoned supercargo, the Select Committee surrendered a man to the Chinese upon the assurance that he would be given a fair trial. No evidence of his trial was ever produced, and soon afterward he was publicly strangled. As a result of this incident the British determined never again to surrender a man to the Chinese for trial.[8] In this case the gunner or his substitute (and there is some evidence that a substitute was surrendered), was strangled for the accidental killing of a man without having had a fair trial according to western standards.

According to Chinese law killing by accident was punishable by fine; killing in self-defense was justifiable; killing

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[6]H. B. Morse, *Chronicle of the East India Company Trading to China* (Cambridge, 1926), V. 2, pp. 99-100; H. B. Morse, *International Relations of the Chinese Empire* (New York, 1910), V. 1, p. 102; Peter Auber *China* (London, 1834, pp. 183-87; James B. Eames, *The English in China* (London, 1909), pp. 96-97.

[7]Morse, *International Relations,* V. 1, pp. 109-117; G. T. Staunton, *Miscellaneous Notes Relating to China* (London, 1850), V. 2, p. 109; S. Wells Williams, *The Middle Kingdom* (New York, 1883), V. 1, pp. 436 and 481-82; M. Huc, *The Chinese Empire* (London, 1855), V. 2, pp. 258-60.

[8]Morse, *Chronicle,* V. 2, pp. 100-109; R. M. Martin, *China* (London, 1847), V. 2, pp. 16-17; Auber, *op. cit.,* pp. 183-87; Eames, *op. cit.,* pp. 96-97.

in an affray or upon suspician of theft was punishable by strangulation; while premeditated murder or killing by gun fire was punishable by decapitation.[9] The Chinese, however, always insisted that cases involving foreigners fell under premeditated murder or killing in an affray, no matter how conclusively the evidence showed it to be accidental or in self defense.[10] The venality and injustice of the law courts made such procedure possible, while the Imperial order of Kienlung, issued in about 1738, demanding "life for life" in case of homicides by foreigners, made it incumbent upon the Chinese officials to secure the execution of a foreigner whenever a Chinese life had been lost.

The *Neptune* affair of 1807 indicates the character of a Chinese trial involving foreigners, and at the same time illustrates the determination to enforce the doctrine of responsibility. A Chinese was killed in an affray with some sailors of the *Neptune* on February 24. The Chinese as usual demanded of the British Chief the surrender of the guilty man. When it was explained that no one knew who had struck the fatal blow the British trade was stopped, and the Chinese officials notified the Chinese merchant who had given security for the ship that he must produce the guilty person. The Security Merchant apparently was subjected to physical punishment and financial extortion for he soon offered a reward of $20,000 to anyone who would produce evidence sufficient to convict the murderer. It was finally arranged that fifty-two sailors should be examined by Chinese magistrates in the British factories. All of the sailors denied having struck the fatal blow. The English would not allow the use of torture, the usual Chinese method of extorting confessions. The next day the Chinese demanded the return of eleven men. One of them, Edward Sheen, after denying that he had struck any Chinaman was told that one of the sailors, Julius Caesar, had reported him as the guilty party.[12], "Captain Rolles then intervened, declaring that Julius Caesar had made no such remark; to which the Mandarin replied that he only said so with a view of extorting the truth from the witness."[13] At the close of the day the mandarines requested the English to allow them to apply torture in order to force acknowledgement of guilt, for only in this way could they bring the affair to a conclusion satisfactory to Chinese standards which demanded that a man could be convicted only upon his own confession.[14] When this was refused the mandarines arbitrarily picked upon Edward Sheen as the guilty man, but reduced their demands from surrender for strangulation to payment of money damages.[15]

Francis Terranova, an Italian on the American ship *Emily* in 1821, did not escape so luckily. He was charged with the killing of a woman by dropping an earthen jar upon her head. The evidence presented at the trial on the American ship indicated that the woman had fallen out of a boat and drowned, while the Chinese witnesses summoned could not have observed the episode of which they spoke. The Chinese magistrate finally said, "he had himself seen the Woman and the Jar. He believed the Man guilty, if he had judged wrongfully it was Heaven's business, and arose in a passion from his chair."[16] He soon departed from the ship without listening to further evidence. The American trade was stopped until Terranova was surrendered. He was then given a

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[9]Morse, *Chronicle,* V. 2, p. 343; Charles Gutzloff, *China Opened* (London, 1838), V. 2, p. 78; Morse, *International Relations,* V. 1, p. 110; Auber, *op. cit.,* pp. 207-08.

[10]Morse, *International Relations,* V. 1, p. 111.

[11]Gutzlaff, *Op. Cit.,* V. 2, p. 78.

[12]Morse, *Chronicle,* V. 3, pp. 40-53; Morse, *International Relations,* V. 1, pp. 103-104.

[13]Morse, *Chronicle,* V. 3, p. 45.

[14]*Ibid,* p. 45; Morse, *International Relations,* V. 1, p. 114.

[15]Morse, *Chronicle,* V. 3, pp. 46-47.

[16]*Ibid,* V. 4, p. 24.

purely Chinese trial, which no foreigners attended; was convicted, and tsrangled within twenty-four hours.[17]

The Chinese at this time also showed utter disregard for international usages as is shown in their demanding the humiliating kotow of foreign envoys who visited the Emperor, and, at Canton, their refusal to communicate directly with foreign officials. The kotow consisted of three kneelings before the throne, and with each kneeling, striking the head three times upon the floor.[18] They also showed a total disregard of the international courtesy and immunity granted ships of war. War ships were not allowed to put into Canton harbor for supplies and re-fitting except under the most desperate circumstances.[19] When war ships were allowed to enter the harbor the Chinese demanded that they pay harbor duties just like ordinary merchant ships.[20] Furthermore, if disturbances occurred involving the death of Chinese, in which sailors from battle ships were implicated, the chief merchants of that country were held responsible for the surrender of the guilty persons even though they had no jurisdiction over war vessels. This last fact was well represented in the H. M. S. *Topaze* affair of 1821, in which a party of marines were attacked by a Chinese mob. In the affray that followed fourteen marines were wounded and two Chinese killed. The commander refused to surrender the two men demanded. The Chinese then stopped the trade and laid the responsibility upon the chief of the British factory.[21]

Thus far only criminal cases have been cited. This has been done because records show no civil suits involving foreigners before a Chinese court. This was quite in harmony with Chinese practice which avoided civil suits in the courts whenever possible, and to this the foreigners were more than willing to accede considering the quality of justice meted out in Chinese courts.[22]

From the above examples it is evident that justice in the Western sense of the word was not to be obtained in a Chinese court, due, to the differences in law, to the doctrine of responsibility which demanded an eye for an eye, and to the barbarous methods of judicial procedure. It thus becomes evident why foreigners objected to Chinese justice, and why the expansion and continuance of commerce necessitated the establishment of extraterritorial jurisdiction.

That the traders in China, especially the English, were aware of the need of extraterritorial jurisdiction was in evidence at an early date by the following statement made after the *Lady Hughes* affair.

> We feel our situation to be such that if any accidental death happen in the future, we think we shall not be able to extricate ourselves from a state of personal danger, without doing that which must forever disgrace us, or abandoning this important commerce.[32]

The Macartney Embassy in 1793 was instructed to request, and did request of the court at Peking, a small detached piece of land which the English might use as a depot for trade, and over which they might exercise police regulation and jurisdiction.[24] Lord Amherst in 1816 was instructed to secure "protection from the violence and injustice of the local government,"[25]

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[17]*Ibid,* pp. 23-27; Morse, *International Relations,* V. 1, pp. 104-105; Tyler Dennett, *Americans in Eastern Asia* (New York, 1922), pp. 86-89.

[18]E. T. Williams, *A Short History of China* (New York, 1928), p. 231; Morse, *International Relations,* V. 1, pp. 48-49, 53-56.

[19]See the cases of the *Centurion* 1741, the *Argo* 1764, the *Leopard* and *Thames,* 1791, and the *Doris,* 1814, in Morse, *International Relations,* V. 1, pp. 97-98.

[20]See the H.M.S. *Argo* cases of 1764, in *Morse, International Relations,* V. 1, pp. 97-98.

[21]*Ibid,* pp. 105-06; Morse, *Chronicle,* V. 4, pp. 18-19 nad 27-41.

[22]Morse, *International Relations,* V. 1, pp. 96-97.

[23]Morse, *Chronicle,* V. 2, p. 105.

[24]*Ibid.,* pp. 237-39.

[25]*Ibid.,* V. 3, p. 279.

and in 1831 the English at Canton requested the British Government to send an embassy to China which, among other things, would place the life and property of British subjects upon a foundation of justice and security against arbitrary action as a necessary prerequisite to the continuance of the trade.[26] The immediate outbreak of the Opium War was a conflict between English vessels and Chinese vessels which had been sent to seize an Englishman charged with killing a Chinese.[27] The English government recognized this close connection between commerce and the establishment of an improved judicial situation when in 1833 it established a court with criminal and admiralty jurisdiction, to be held on board British ships at Canton under the direction of the new Superintendent of trade. Out of deference to Chinese sovereignty, however, its immediate establishment was postponed.[28]

The situation by 1840 was plainly this. Given the existing system of justice in China, expansion of trade to numerous ports or to the interior without the protection of extraterritoriality was impossible. Either the expansion of trade must cease or extraterritoriality must be established. To talk of the cessation of trade expension would be idle. Extraterritoriality was thus forced into China as the inevitable consequence of the economic and industrial expansion of the West.

We are now ready to examine the precedents and customs which pointed toward extraterritoriality, and which made the demand for its establishment not unreasonable. There are a great number of contradictory precedents, some of which support extraterritorialiyt while others oppose it. It is my belief, however, that the balance of precedent and custom was decidedly on the side of the right of extraterritorial jurisdiction. Let us examine those precedents favoring extraterritoriality. First of all htere was a precedent in English experience in China, based upon four cases and two written agreements, which allowed the English to exercise criminal jurisdiction over, and apply English law to, their nationals who had violated Chinese law.[29]. This was supported by at least one case in Portuguese experience at Macao.[30] Second, the English had established a precedent broken only by the *Lady Hughes case,* of refusing to surrender their nationals to trial by Chinese courts sitting in Chinese surroundings. This position was generally adhered to by the French, Dutch, and other nations at Canton after 1780.[31] The Americans were the only exceptions as illustrated in the Terranova case of 1821, referred to above.[32] The third precedent, supported by four sases, was that of interference by foreign officials in cases involving foreigners. In two instances this amounted to the holding of the trials on foreign ships or in foreign factories.[33] Fourth was the precedent that civil cases were always settled outside of Chinese courts. The fifth precedent was based upon a number of cases. Its essence was that the Chinese demanded the surrender of a European only when the death of a Chinese had been caused by contact with the foreigners. In all cases of less consequence they either di dnot demand the gulity party or shortly

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[26] *Ibid.,* V. 4, p. 323.

[27] Morse, *International Relations.,* V. 1, pp. 237-38 and 243-46.

[28] *Ibid.,* pp. 119-20; Liu, *Op. Cit.,* pp. 86-87; 3 and 4 Will, 1V. Cap. 93; *State Papers,* V. 20, pp. 260-262.

[29] See Amoy case of 1687 in Morse, Chronicle, V. 1, p. 64; Eames, *Op. Cit.,* p, 41, and the *Cadogan* case, 1721, the *Royal George* case, 1810, and the *Topaze* case, 1821 in Morse, *International Relations,* V. 1, pp. 101 and 104-05. For the agreements see Morse, *Chronicle,* V. 1, pp. 168-69 and 193; and Eames, *Op. Cit.,* pp. 60-61.

[30] Morse, *International Relations,* V. 1, pp. 100-101.

[31] *Ibid.* review cases, pp. 100-107.

[32] *Ibid.,* see especially pp. 104-05.

[33] See the *Madras* case, 1800, the *Neptune* case, 1807, the *Emily* case, 1821, and the *Lascaro* case of 1833, in Morse, *International Relations,* V. 1, pp. 103, 104-5, 107.

afterward dropped all charges.[35] The sixth and last precedent is rather general but of great importance. At all times the Chinese held the chief factors of the respective foreign merchants responsible for the good behavior of all foreigners of their nationality, and only in cases of homicide did the Chinese officials participate. In homicide cases they still held the chief factors responsible for the arrest and surrender of the guilty man, but they alone wished to try him.[36]

Against these precedents which argue for the right of extraterritoriality we can advance but three. First, the mandarines always demanded the surrender of someone whenever a Chinese was killed. This claim to absolute sovereignty was weakened however, by the fact that they did not always enforce it, and never did they directly secure arrest of the guilty party. In the second place, foreign traders in eight cases out of about twenty-five surrendered their nationals to Chinese law; and in four of these the foreigners were executed,[37] while in three monetary damages were paid.[38] Third, the mandarines in some cases punished Chinese citizens who committed acts against foreigners, provided the foreigners registered a complaint.[39] The Chinese criminal code also provided that foreigners who came to the Empire must submit to its laws and be tried and sentenced accordingly.[40]

From this array of precedents one fact stands out; namely, that only in cases involving homicide did the Chinese officials try to exercise their sovereignty. In all other cases, and even for the arrest of suspected homicides, the officials allowed and expected the foreigners to exercise jurisdiction over their own nationals. In most instances China thus refused ot assume the responsibilities of full sovereignty, but wished to exercise it to the last degree in isolated cases. The result was a state of chaos in which the foreigners exercised certain rights of jurisdiction, but did not have sufficient power to preserve order. It was to remedy this anamalous situation that England was prompted to establish a court in China, in 1833 by the Parliamentary act referred to above.

If precedent strongly hinted of extraterritoriality, and conditions made its adoption necessary and inevitable, it did not actually come into existence except by the force of war. The treaty of Nanking which closed the Opium War said nothing definitely about extraterritoriality, but it established British Consular Officials in China and it was clearly understood that extraterritorial rights were to be enjoyed by British traders. Article 13, of the general trade regulations made in 1843, provided for the exercise of both civil and criminal jurisdiction over British subjects by British Consuls.[41]

The best definiiton of extraterritorial rights, however, was made in the American treaty of Wanghia in 1844. It is interesting to note the opportunity which the American envoy, Caleb Cushing took to reverse the earlier American practice of submission to Chinese law. The ample and clear provisions of this treaty were enjoyed by all other powers, because of the most-favored-nation clauses. Aritcle 21 provided for criminal extraterritorality in the following words:

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[34]*Ibid.*, p. 96.

[35]See *Richmond* case, 1735, in Morse, *Chronicle* V. 1, p. 236, and the *Madras* case, 1800, in Morse, *International Relations,* V. 1, p. 103.

[36]A review of all cases mentioned will show this. Note cases in Morse, *International Relations*, V. 1, pp. 97-108, see also statement by contemporary writer in Morse, *Chronicle* V. 4, p. 36.

[37]Morse, *International Relations*, V. 1, French case, 1754; Frances Scott, in 1773; *Success* case, 1780; *Lady Hughes,* 1784; *Terranava* case, 1821, pp. 101-2 and 104.

[38]*Ibid.*, pp. 101-103 and 104. *King George* case, 1722, *Neptune* case 1807, and *Lady Melville* case, 1821.

[39]*Ibid.*, note cases pp. 107-08.

[40]George Staunton, *Penal Code of China* (London, 1810), p. 36.

[41]W. W. Willoughby, *Foreign Rights and Interests in China* (Baltimore, 1920), pp. 19-20; *Maritime Treaties,* V. 1, p. 388.

> Subjects of China who may be guilty of any criminal act towards citizens of the United States shall be arrested and punished by the Chinese authorities according to the laws of China, and citizens of the United States who may commit any crime in China shall be subject to be tried and punished only by the consul or other public functionary of the United States thereto authorized according to the laws ofthe United States.

Article 24 provided that civil cases involving Chinese and Americans should be settled by public officers of both nations acting in conjunction. Article 25 provided that cases involving Americans only be settled by the American authorities, while cases involving foreigners other than Chinese, and Americans should be regulated by treaties existing between the United States and such governments. Article 16 provided for special procedure in the collection of debts.[42]

Such then, in brief is the origin of extraterritoriality in China. No attempt has been made in this paper to do more than explain its origin in the light of recently published facts which justify a revision of conclusions reached by some early writers. On the basis of these facts one is waranted in concluding that extraterritoriality was not maliciously forced upon China, but grew out of the exigencies of the situation. The expansion of world culture brought together two great and widely differing civilizations. Their legal systems and political ideals were so much opposed that an extensive intercourse between them necessitated some working agreement. This working agreement as first developed through custom and practice was very indefinite and unstable. Only by a definite treaty agreement could a satisfactory and necessary system be established. Since China was unwilling to grant this peaceably it was forced upon her htrough war. At present, when the abolition of extraterritoriality in China is constantly being discussed, it is well to note that the system grew up to satisfy a definite need and that before it is abolished we must be reasonably sure that the need no longer exists. If the conclusions here reached are correct, the Chinese Nationalists cannot base their demands for the abolition of extraterritoriality upon its original injustice and illegality, but must found their claims for its abolition upon a *rebus sic stantibus*.

[42]See treaty in Malloy, *Treaties and Conventions*, (Washington, 1910), V. 1, pp. 190 and ff.

Tests on Gas Grain Treater for the Control of Smut

(Continued from page 102)

tral part of the sack, the damage may not be extensive.

A more important feature is the control of the smut fungus. There is a low smut percentage in the sample drawn from the center of the sack when left four days after treatment but the portion of the sack in which there is fairly good control may be small. It is significant that the percentage of smut in wheat grown from the sample from the periphery, i. e., to a depth of two inches at various points on the outside, is as high as in the untreated check.

The gas treatment when compared with the standard formaldehyde dip is decidedly inferior; in samples where the smut control is reasonably good, germination is weak. However, the copper carbonate treatment, now in common use, eliminates the more important disadvantages of the formaldehyde dip and at the same time gives adequate smut control. On this account the adoption of formaldehyde gas treatment cannot be recommended.

Program of the Seventh Annual Meeting of the Northwest Scientific Association

December 29-30, 1930, Davenport Hotel, Spokane, Washington.
Registration Desk, Mezzanine Floor, Davenport Hotel.

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REDUCED RATES FOR MEETINGS

A convention certificate will be sent to each member who resides outside the city of Spokane. This certificate, if presented to railroad agents at starting point, will entitle members to a round trip fare of one and one-half the regular one way fare. Dates of sale of such tickets will be December 26 to December 30; final return limit January 2, 1931. In addition to these rates the special Christmas rates of fare and a third will be in effect. Members using the latter will, however, have to leave their starting point not later than December 25.

MEMBERSHIP

Membership in the Association is open to any one paying the annual dues of one dollar. Members receive wtihout additional cost the issues of Northwest Science, the official publication of the Association.

HEADQUARTERS

The Davenport Hotel will be the headquarters of the Association and all meetings will be held in the hotel rooms.

REGISTRATION

The registration desk will be found on the Mezzanine Floor of the Davenport Hotel. All old members should register and receive their official badge for the meeting. At the same time they should see that their dues are paid. New mem-

bers should fill out an application blank and pay the annual dues.

Registration will begin at 9:00 A.M. December 29 and continue until the following noon. All are urged to register as early as possible.

ANNUAL DINNER

Luncheons—Breakfasts

The annual dinner will be held at 6:30 P.M. on Monday, December 29, in the Hall of the Doges. Reservations should be made at the time of registration. Price, $1.50. Members and guests are invited to attend. The speaker of the evening will be John A. Kostalek, Retiring President of the Association. Subject "The Utilization and Conservation of Our Carbon Resources."

A luncheon of the Association will be held on Tuesday, December 30, in the Elizabethan Rooms. Price, seventy-five cents. Ernest O. Holland, President, State College of Washington, will speak.

Geologists and their friends will lunch together on Monday, December 29 in the Hall of the Doges. Price, seventy-five cents. Please make reservations at the registration desk.

There will be a Sigma Xi breakfast for members and guests on Tuesday morning at 8 o'clock in the East Banquet Hall. Reservations should be made at the time of registration. Price, sevnety-five cents.

A Phi Delta Kappa breakfast for members and friends will be held on Tuesday morning, December 30, in Room 200. Price seventy-five cents. Reservations should be made at the time of registration.

Monday, December 29

9:00 A. M.—Registration, Mezzanine Floor.

10:00 A. M.—General Session. Elizabethan Rooms, A, B, C.

12:00 Noon—Geologists' Luncheon, Hall of the Doges.

1.30 P. M.—Section Meetings

Botany-Zoology. Elizabethan Rooms B, C.
Chemistry-Physics. Elizabethan Rooms D, E.
Education. Room 200.
Engineering. Elizabethan Room A.
Forestry. East Banquet Hall.
Geology-Geography. Mandarin Room.
Social Science. Hall of the Doges.

3:30 P. M.—General Session. Medical Program. Elizabethan Rooms A, B, C.

6:30 P. M.—Annual Dinner. Hall of the Doges.

Tuesday, December 30

9:00 A. M.—General Session. Business Meeting. Elizabethan Rooms A, B, C.

10:00 A M.—Section Meetings

Botany-Zoology. Elizabethan Room A.
Chemistry-Physics. Elizabethan Rooms, D, E.
Education. Room 200.
Geology-Geography. Elizabethan Room B.
Social Science. Elizabethan Room C.

12:00 Noon—Luncheon. Elizabethan Rooms.

1:30 P. M.—Section Meetings

Botany-Zoology. Mandarin Room.
Chemistry-Physics. Elizabethan Rooms D, E.
Education. Room 200
Engineering. Elizabethan Rooms A, B, C.
Forestry. East Banquet Hall.
Social Science. Hall of the Doges.
General Session.

Monday, December 29

10:00 A. M.—Elizabethan Rooms A, B, C. President F. A. Thomson presiding.

Address: Some Assets of Present Day Research in the Inland Empire—T. C. Spaulding, State University, Missoula, Montana.

3:30 P. M.—Medical Program, Elizabethan Rooms A, B, C.

Dr. S. E. Lambert, Spokane, Washington, Chairman.
Dr. Donald E. Palmer, Spokane, Washington, Secretary.

1. Business Meeting.
2. Constipation; Causes, Significance and Treatment—Dr. C. M. Anderson, Spokane, Washington.
3. Rickets and Vitamin D—Dr. A. O. Adams, Spokane, Washington.
4. Newer Diagnostic Methods.
   (a) Bronchoscopy—Dr. A. N. Codd, Spokane, Washington.
   (b) Ventriculography in Head Injuries—Dr. George Downs, Spokane, Washington.
5. Acute Appendicitis—A Moving Picture Demonstration.

6:30 P. M.—Annual Dinner. Hall of the Doges.

President F. A. Thomson, Chairman.
Address of Retiring President, John A. Kostalek, University of Idaho, Moscow, Idaho. Subject: "The Utilization and Conservation of our Carbon Resources."

Tuesday, December 30

9:00 A. M.—Annual Business Meeting. Elizabethan Rooms A, B, C.

President Francis A. Thomson, Chairman.
Reports of Officers and Committees.
Election of Officers.

12:00 Noon—Luncheon
Elizabethan Rooms
Address: E. O. Holland, President, State College of Washington.

Monday and Tuesday, December 29-30

Botany-Zoology

F. L. Pickett, State College of Washington, Pullman, Washington, Chairman.
R. A. Diettert, University of Idaho. Moscow, Idaho, Secretary.

MONDAY, 1:30 P. M.

Elizabethan Rooms B, C.

1. Some Phases of Earthworm Neurology—Howard B. Stough, University of Idaho, Moscow, Idaho. 25 Minutes.
2. Northwestern Cereal Footrots—Roderick Sprague, State College, Corvallis, Oregon. 10 Minutes.
3. Effect of Drought upon Desert Vegetation—Charles E. Cone and D. C. Thiemens, Ephrata High School, Ephrata, Washington. 10 Minutes.
4. Some Casual Observations on Hatching Eggs of Chinese Pheasants Under Adverse Conditions—Ellis B. Haris, Spokane University, Spokane, Washington. 5 Minutes.
5. Observations on the Narcissus Nematode—C. R. Stillinger, U.S.D.A., Spokane, Washington. 10 Minutes.

TUESDAY, 10:00 A. M.

Elizabethan Room A.

1. Landscape Gardening—R. A. Jones, Spokane, Washington. 15 Minutes.
2. Some Algae of the Inland Empire—Dudley Preston, State College, Pullman, Washington. 15 Minutes.
3. Some Algae of Flathead Lake—Charles W. Waters, State University, Missoula, Montana. 15 Minutes.
4. Abnormal Conjugation in Spirogyra—R. A. Diettert, University of Idaho, Moscow, Idaho. 10 Minutes.
5. Opportunities for Botanical Field Work in Washington—F. L. Pickett, State College, Pullman, Washington. 40 Minutes.

TUESDAY, 1:30 P. M.

Mandarin Room

1. Business Meeting.
2. A Genetic and Cytologic Study of Wheat-Rye-Wheat Back Crosses—V. H. Florell, U.S.D.A.; University of Idaho, Moscow, Idaho. 20 Minutes.
3. Unnecessary Destruction of Natural Areas by Commercial Interests—Phillips G. Putnam, U. S. Biological Survey. Illustrated. 15 Minutes.
4. Food Habits of Upland Game Birds of the Pacific Northwest (A Preliminary report)—Mrs. Anne M. Leffingwell, State College, Pullman, Washington. 10 Minutes
5. Applied Biology in the Northwest—Thomas R. Large, Lewis & Clark High School, Spokane, Washington. 15 Minutes.

Chemistry-Physics

C. M. Brewster, State College of Washington, Pullman, Washington, Chairman.

J. G. McMacken, Lewis and Clark High School, Spokane, Washington, Secretary.

MONDAY, 1:30 P. M.

Elizabethan Rooms D and E

1. Electro-Optical Modifications of Light Waves—L. H. Stauffer, University of Idaho, Moscow, Idaho. 25 Minutes.
2. Some Aliphatic Compounds of Selenium—W. E. Bradt, State College, Pullman, Washnigton. 15 Minutes.
3. Methods of Xylose Extraction from Wheat Straw—B. C. Neustel, Whitworth College, Spokane, Washington. 10 Minutes.
4. The Inverse of the Faraday Effect—A Progress Report—Lawrence Foskett, University of Idaho, Moscow, Idaho. 15 Minutes
5. Analysis of Persulfuric Acid—L. I. Gilbertson, State College, Pullman, Washington. 10 Minutes.

TUESDAY, 10:00 A. M.

Elizabethan Rooms D, E.

1. Effect of Gases on Gold Sols—W. H. Cone, University of Idaho, Moscow, Idaho. 10 Minutes.
2. The Temperature at Which Unbound Water is Completely Frozen in a Biocolloid—J. L. St. John, State College, Pullman, Washington. 10 Minutes.
3. Some Modifications in the Soap Titration Method of Calcium Determination—Donald Bolin, University of Idaho, Moscow, Idaho. 5 Minutes.
4. The Electrochemical Reduction of 2-4-Dinitro Anisol—E. F. Farnau, R. Parrish and W. E. Bradt, State College, Pullman Washington. 15 Minutes.
5. Preliminary Report on a Lubrication Testing Machine—Kenneth Fitzsimmons and B. L. Steele, State College, Pullman, Washington. 10 Minutes.
6. Microscopic Projections of Crystal Growth; a Demonstration—Robert Forrester, State College, Pullman, Washington. 10 Minutes.

1:30 P. M. Elizabethan Rooms D, E.

1. Business Meeting.
2. Quantitive Experiments for High School Physics—S. C. Roberts, State College, Pullman, Washington. 15 Minutes
3. A Review of Methods for the Preparation of Selenic Acid and the Selenides—L. I. Gilbertson, State College, Pullman, Washington. 15 Minutes.

4. Some Effects of Chemical Treatment of Alkali Soils—H. P. Magnuson and J. C. Marr, University of Idaho, Moscow, Idaho. 12 Minutes

5. Hydrogen Ion Concentration of the Thick and Thin Portions of Egg White from Eggs of Different Quality—J. L. St. John and Iva Hanson Flor, State College, Pullman, Washington. 10 Minutes.

6. Benzoic Acid Content of Western Cranberries—R. P. Cope and Howard J. Strauch, State College, Pullman, Washington. 10 Minutes

7. Recent Developments in the Chemistry of Apple Washers in North Central Washington—Charles C. Cooley, Omak High School, Omak, Washington. 10 Minutes.

Education

S. G. Witter, Part Time Schools, Spokane, Washington, Chairman.
Charles R. Randall, Veradale, Washington, Secretary.

MONDAY, 1:30 P. M.

Room 200

1. A Glance at Other Systems of School Finance—F. T. Hardwick, Whitworth College, Spokane, Washington. 20 Minutes.
2. Taxation and Public School Finance —O. C. Pratt, Superintendent of Schools, Spokane, Washington. 15 Minutes.

TUESDAY, 10:00 A. M.

Room 200

1. The Relation of Intelligence to Student Teacher Success—Clark Frasier, State Normal School, Cheney, Washington. 20 Minutes.

2. Our Changing High School Curriculum—J. D. Meyer, Hillyard High School, Spokane, Washington. 20 Minutes.

TUESDAY, 1:30 P. M.

Room 200

1. Business Meeting.

2. Home Study—John Shaw, Havermale, Junior High School, Spokane, Washington. 15 Minutes.

3. What Has Modern Psychology to Offer in Training the Pre-School Child?—I. N. Madsen, State Normal School, Lewiston, Idaho. 20 Minutes.

4. Survey of Teaching Conditions in the Northwest—Raymond Hawk, State Normal School, Cheney, Washington. 20 Minutes.

5. Attitudes of High School Students Towards Latin—W. F. Standeford, Public Schools, Burke, Idaho. 10 Minutes

6. The Validity of an Estimation Blank in Rating Prospective Teachers—C. I. Erickson, State College, Pullman, Washington. 10 Minutes.

Engineering

Ivan C. Crawford, University of Idaho, Moscow, Idaho, Chairman.
Richard McKay, Washington Water Power Company, Spokane, Washington, Secretary.

MONDAY, 1:30 P. M.

Elizabethan Room A

1. Comparative Costs of Oil Burners (Second Progress Report)—F. W. Candee, State College, Pullman, Washington. 15 Minutes.
2. The Theory of Crushing and Grinding—A. W. Fahrenwald, School of Mines, Moscow, Idaho. 30 Minutes.

TUESDAY, 1:30 P. M.

Elizabethan Rooms A, B, C.

Joint Sesion with Geology-Geography Section.

1. Business Meeting.

2. Resume of the Status of Topographical Mapping in the United States—A. D. Butler, Ctiy Engineer, Spokane, Washington. 15 Minutes.

3. Water Supply Economics in Eastern Washington and Northern Idaho—E. H. Collins and Ellery Fosdick, Washington Water Power Company, Spokane, Washington. 30 Minutes.

4. The Gas Fields of Montana—Eugene S. Perry, State School of Mines, Butte, Montana. 20 Minutes.

5. Activities of the Washington Natural Resources Committee—L. K. Armstrong, Spokane, Washington. 15 Minutes.

6. Origin of the So-called Palouse Topography—F. B. Laney, University of Idaho, Moscow, Idaho. 15 Minutes.

Forestry

James C. Evenden, Forest Insect Field Station, Coeur d'Alene, Idaho, Chairman.
A. L. Gibson, Forest Insect Experiment Station, Coeur d'Alene, Idaho, Secretary.

MONDAY, 1:30 P, M.

East Banquet Hall

1. Chemical Utilization of Wood—E. C. Jahn, School of Forestry, Moscow, Idaho. 30 Minutes.

2. Phenology as an Instrument of Forest Administration—E. L. Kolbe, Pacific Northwest Experiment Station, Portland, Oregon. 20 Minutes.

3. Relation of Dry Cycles to Forest Uses and Forest Industries—Walter H. Meyer, Pacific Northwest Experiment Station, Portland, Oregon. 20 Minutes.

4. The Role of Airplanes in Forestry —H. R. Flint, U. S. Forest Service, Missoula, Montana. 30 Minutes.

5. Forest Fire-weather Forecasting—F. C. Crombie, U. S. Weather Bureau, Spokane, Washington. 20 Minutes.

TUESDAY, 1:30 P. M.

East Banquet Hall

1. Business Meeting.

2. Some Relations Between the Water Content of Wood and the Cell Tissue—J. H. Ramskill, State University, Missoula, Montana. 30 Minutes.

3. Spread and Development of White Pine Blister Rust in Northern Idaho—H. N. Putnam, U. S. Blister Rust Service, Spokane, Washington. 15 Minutes.

4. Status of Forest Insects in the Northern Rocky Mountain Region —J. C. Evenden, Forest Insect Field Station, Coeur d'Alene, Idaho. 15 Minutes.

5. Sources of Regeneration Following Fires in the Western White Pine Forest—R. H. Weidman, Northern Rocky Mountain Experiment Station, Missoula, Montana. 20 Minutes.

6. New Stand Tables for the Western White Pine Type—I. T. Haig, Northern Rocky Mountain Experiment Station, Missoula, Montana. 20 Minutes.

7. Silvicultural Fallacies — Gerhard Kempff, School of Forestry, Moscow, Idaho. 20 Minutes.

Geology-Geography

Eugene S. Perry, State School of Mines, Butte, Montana, Chairman.
Otis W. Freeman, State Normal School, Cheney, Washington, Secretary.

MONDAY, 1:30 P. M.

Mandarin Room.

1. Studies of the Geology of Walla Walla—Benjamin H. Brown, Walla Walla, Washington. 15 Minutes.
2. New Light on Mountain Building in Montana—Charles H. Clapp, President, State University, Missoula, Montana. 15 Minutes.
3. Stream Piracy in the Coast Range of Oregon—D. C. Livingstone, University of Idaho, Moscow, Idaho. 20 Minutes.
4. Some Observations on the Geology of Pend O'reille County—W. Glenn Bennett, State College, Pullman, Washington. 18 Minutes.
5. Geographic Divisions of the Columbia Plateau in Washington—O. W. Freeman, State Normal School, Cheney, Washington. 8 Minutes.
6. Note on Recent Discoveries of Mammalian Bones in Eastern Washington—M. A. Search, State College, Pullman, Washington. 8 Minutes.

TUESDAY, 10:00 A. M.

Elizabethan Room B

1. Business Meeting.
2. Note on Some Structures in Columbia River Basalt Near Cooks, Washington—Claude Fowler, State Collegt of Washington, Pullman, Washington. 12 Minutes.
3. Fossil Plants of Miocene Age Near Whitebird, Idaho—Thomas R. Ashlee, University of Idaho, Moscow, Idaho. 20 Minutes.
4. A Tertiary Section in the Lower Okanogan Valley—Harold E. Culver, State College, Pullman, Washington. 12 Minutes.
5. Potato Hill, An Ancient Volcanic Peak near Deary, Idaho—F. B. Laney, University of Idaho,, Moscow, Idaho. 10 Minutes.
6. Correlation in the Belt Series Across Northwestern and Central Montana—Charles H. Clapp, President, State University, Missoula, Montana. 15 Minutes.
7. The English and Scandinavian Equivalent of the Belt Series—A. V. Corry, State School of Mines, Butte, Montana. 15 Minutes.
8. Special Fetures of Hot Water Wells in Boise Valley, Idaho—Thomas H. Hite, Bureau of Mines and Geology, Moscow, Idaho. 20 Minutes.

Social Science

T. S. Kerr, University of Idaho, Moscow, Idaho, Chairman.
Louis S. Livingstone, Lewis and Clark High School, Spokane, Washington, Secretary.

MONDAY, DECEMBER 29, 1:30 P. M.

Hall of the Doges

1. Juvenile Delinquency—R. M. Webster, Judge Superior Court, Spokane County, Spokane, Washington. 30 Minutes.
2. The Changing Concept of the New Competition—R. B. Heflebower, State College, Pullman, Washington. 30 Minutes.

TUESDAY, 10:00 A. M.

Elizabethan Room C.

1. The Advent of the Railways into the Pacific Northwest—E. A. Bryan, State College, Pullman, Washington. 30 Minutes.
2. Missions in the Northwest—George Weibel, Gonzaga University, Spokane, Washingtno. 30 Minutes.
3. The Boss on the Barrel: The Advent of the Business Senator—H. J. Deutsche, State College, Pullman, Washington. 25 Minutes.

TUESDAY, 1:30 P. M.

Hall of the Doges

Round Table Discussion: The Political and Economic Aspects of

Our Present Business Depression—Fifteen Minute Discussions by:
Ramond Becher, North Central High School, Spokane, Washington.
C. R. Strand, Coeur d'Alene High School, Coeur d'Alene, Idaho.
J. E. Retherford, University of Idaho, Moscow, Idaho.
C. J. Brosnan, University of Idaho, Moscow, Idaho.

Rayon and other synthetic cellulose fabrics will soon be underselling cotton goods as they are now underselling silk. So prophesies Professor Charles E. Mullin, head of the division of textile chemistry at Clemson College. One company, he states, has already announced that it can produce viscose yarn at a lower price than that of medium or fine cotton yarns of the same size. Synthetic fibers are competing with silk not only in price, but also in fineness. It is now possible to produce filaments that are two and one half times finer than those of true silk. These are being made on a commercial scale both in America and abroad. It requires more than 4,225 miles of one of these filaments to weigh a pound.

As the result of an unusually heavy rainfall in May, the burning sands of Death Valley, the hottest spot on earth, blossomed into an Arabian Night's blanket of color, says Dr. F. A. Thackery, senior agriculturist in charge of the Bureau of Plant Industry's date investigations at Los Angeles, Calif. When Doctor Thackery and his companions drove into that region on their way to the department's date plantings at the Furnace Creek Ranch, they found more than 90 species of comparatively rare plants in bloom. The oldest inhabitants on the outskirts of this valley told the Government botanists that such flowering occurs about once in 20 or 30 years. This indicates that the flower seeds remain dormant for many years, awaiting the rains necessary for their development.

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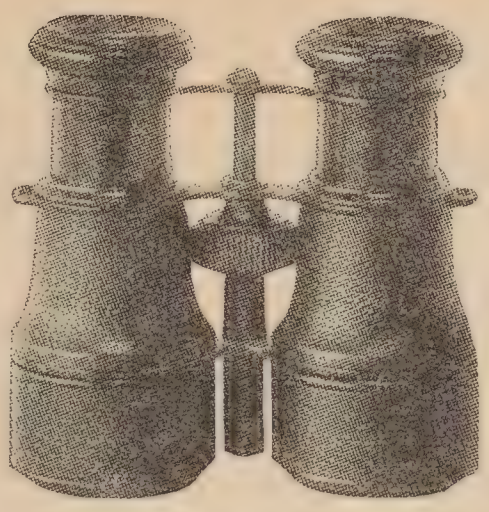

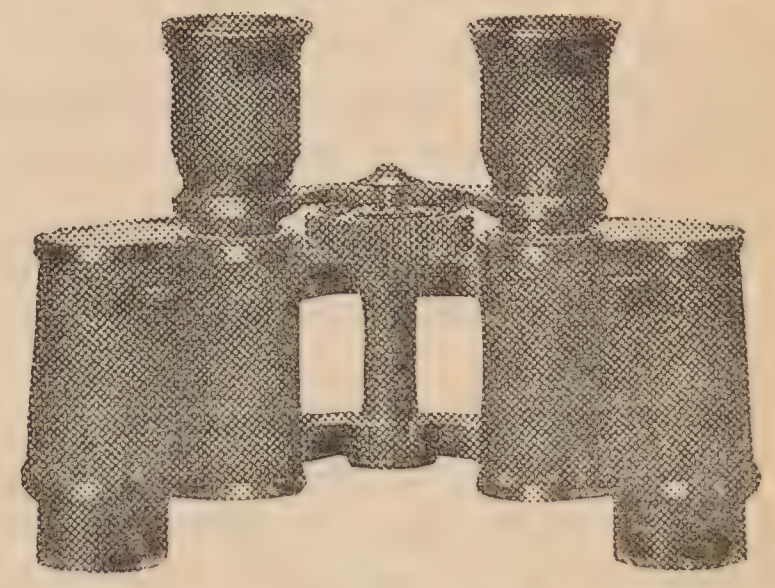

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The Association is not responsible, as a body, for the facts and opinions advanced in the papers published by it.

The Seventh Annual Meeting

By J. W. HUNGATE, State Normal School, Cheney, Wn.

THE seventh annual meeting of the Northwest Scientific Association was held at Spokane, Washington in the Davenport Hotel on Monday and Tuesday, December 29 and 30, 1930. The meetings were presided over by the president, Francis A. Thomson, President of the State School of Mines, Butte, Montana.

The opening address at the general session on December 29 was delivered by T. C. Spaulding, Dean of Forestry, State University at Missoula, Montana, on the subject, "Some Aspects of Present Day Research in the Inland Empire." Following the address members engaged in a general discussion. The central theme of the discussion seemed to be the necessity for desirable publicity for scientific research. A second general session was held during the afternoon at which papers were presented by members of the medical section.

The anuual dinner of the association was held the same evening in the Hall of the Doges, Davenport Hotel. On this occasion the annual address of the retiring president was given by Dr. John A. Kostalek, University of Idaho, Moscow, Idaho, on the subject, "The Utilization and Conservation of Our Carbon Resources."

At the business meeting held on the morning of December 30, the most important topic considered was the question of affiliation with the A.A.A.S. After some discussion the association instructed the secretary to arrange for affiliation with the A.A.A.S. as an academy of science, retaining, however, the present name.

A luncheon of the association was held at noon on the same day. At the close of the luncheon an address was given by Dr. E. A. Bryan, State College of Washington, Pullman, Washington, on the subject, "The Advent of the Railroads in the Pacific Northwest." On this occasion also a resolution was presented commemorating the services of the late Dr. M. F. Angell, a charter member of the association and its first president. As a mark of respect, members rose and stood for a moment in memory of Dr. Angell.

The council, at the business meeting on December 29, set the date of the 1931 meeting for Tuesday and Wednesday, December 29 and 30.

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A Memorial to Martin Fuller Angell, 1878-1930

Dean, College of Letters and Science, University of Idaho

It is with the keenest regret that the Northwest Scientific Association has to chronicle the death of one of its founder members and first President; Dean M. F. Angell, of the University of Idaho.

Dr. Angell was untiring in his efforts to foster an appreciation of science in its bearing on the practical as well as the cultural side of modern life. He had unbounded faith in the capacity of our society to some such purpose.

As a man Dr. Angell was held in high esteem by his associates, whether in the teaching field, in research, administration, business, social life, or in the art of Isaac Walton.

This esteem was founded on his demonstrated record of superior sportsmanship in all his dealings.

He relished nothing better than a good fight in what he was convinced was a worthy cause but he harbored no resentments.

He was untiring in meeting the many calls put upon him and exhausted his strength in serving the cause of education.

Even as one stricken he was undaunted, unflinching in doing his duty as he saw it. Such a man among men, he left us in the prime of life and cannot easily be replaced.

He was married to Mary Alta Gilbert in 1903 who with two sons and two daughters survives him.

Adopted by the Northwest Scientific Association December 30, 1930.

Food Habits of Some Game Birds of The Pacific Northwest

(A Preliminary Report)

By ANNE MACLAY LEFFINGWELL, State College of Washington

ONE of the major factors determining the reproduction of game birds over a given area is the supply of food in the region. With this in mind we have undertaken to make detailed analyses of the food and feeding habits of some of the upland birds of the Northwest (These investigations were begun in conjunction with life history studies being carried on by the late Dr. Dana J. Leffingwell of Pullman, Washington.)

The new material which will be presented herewith has been obtained in a more or less desultory manner, since systematic collections for study have not yet been made. However, the writer has requested permission to take at least four Hungarian partridges per month for the purpose of securing seasonal data.

The birds from which the following analyses were made were collected during the hunting season in October and November, or are those which have been accidentally or illegally killed. For the latter, thanks are due especially to Mr H M. Worcester of Whitman County for his courteous cooperation.

The Ring-Necked Pheasant

McAtee and Beal (1) in 1912 made investigations of the stomachs of twelve pheasants collected in Washington and Oregon. About 34 per cent of the total food was found to be wheat and oats. This, however, was thought to be waste grain as the birds were taken in September, October and December, after the harvest period. Four birds contained 654 kernels of wheat. Four contained 990 grains of oats and two, 227 peas. Three stomachs contained 379 pine seeds and 23 acorns of *Quercus garryana* were found in one. In eight stomachs 8369 seeds of noxious weeds or those of neutral value were found, these included, in a single bird, about 8000 seeds of *Alsine media*.

Due largely to the conflicting opinions as to the status of the Ring-necked pheasant (*Phasianus colchicus torquatus*) in relation to agriculture, nationwide investigations, similar to that of McAtee and Beal, have been and are being carried on (2), (3), (4), (5). It is evident that the only possible and conclusive solution to this problem is the systematic investigation of the food taken within restricted areas. Because of the fact that the pheasant has adapted itself most readily to the cultivated sections it is credited with destruction of cereal crops, chiefly wheat and corn. In most cases, however, we can safely say that the grain content of the food is waste, picked up after harvest. Weed seeds are apparently as well liked as grains. This is shown by a stomach from a bird taken at Yakima, Washington, which contained 8500 seeds of prostrate amaranth (*Amaranthus blitoides*), these weeds constituting 90 per cent of the total feeding.

In our examination of fourteen stomach, all taken between the months of October and February, the greatest single constituent was found to be the fruit of native shrubs, snowberry (*Symphoricarpus*), hawthorn (*Crataegus*), and rose (*Rosa*), constituting 32 75 per cent of the total. Weed seeds averaged 23.71 per cent of the food, of which the most frequently found were prostrate amaranth (*A. blitoides*), wild buckwheat (*Polygo-*

num convolvulus), teasel (*Dipsacus sylvestris*), and lamb's quarter (*Chenopodium album*).

The insect food was almost nil, one bird containing two Hemiptera and one (*Arachnid*) spider. Occasional fragments of grasshopper (*Orthoptera*) were found. The total animal matter averaged only 0.08 per cent.

Many have complained that the pheasants destroy fruits and vegetables, especially tomatoes, melons, and leafy garden plants. This is said to be due to an insufficient supply of drinking water and California game officials maintain that this destruction can be avoided if containers of water are made available to the birds.

Pheasants are evidently less able to withstand severe cold and heavy snow, than are the Hungarian and native game birds, due to the fact that they are less able to seek food. Several birds, found dead, were sent in to us for examination during the severe weather in January and February of 1928. These were found to have starved, while during the same period no other game birds were sent in or reported dead.

Table 1 summarizes the stomach analyses of thirteen birds. The vegetable material was divided into four parts: crops, which include grain, garden truck, and all vegetable material raised by man; weed seeds; seeds of shrubs including the fruits and seeds of plants neutral in their relation to agriculture; and leafy material, which includes grass, buds, etc. The percentages given are the percentages of the total bulk of the various foods.

TABLE I. Showing analyses of fourteen Ring-necked Pheasants—Percentage of total bulk of food.

No.	Animal matter	Crop plants	Weed seed	Shrubs	Grass	Debris
11	0.	1.	99.	0.	0.	0.
24	.....	7.5	87.25	5.25	.....	.....
25	1.	.....	35.	55.	3.	6.
26	.....	.....	.....	55.	.....	45.
23	.....	60.	.....	.....	.....	40.
22	.....	.....	.....	95.	.....	5.
16	.....	.....	.....	100.	.....	.....
5	.....	.....	.....	40.	44.	16.
6	.....	69.	.....	6.	.....	25.
10	.....	60.	11.5	12.	4.	12.5
.....	.....	7.	50.5	12.5	.....	30.
20	.....	.....	5.	20.	.....	75.
.....	.....	.....	20.	25.	.....	55.
Total	1.	204.5	308.25	425.75	51.	309.5
Avg.	.08	15.73	23.71	32.75	3.93	23.8

The Hungarian Partridge

The Hungarian Partridge (*Perdix perdix*) presents a somewhat different problem. The feeding habits are in general much the same, but the Hungarian is more selective than the pheasant. It has within the last decade become very general over most of the Northwest, and seems particularly well suited to the cultivated grain lands. I am informed, however, that there seems to a shifting from the wheat districts of the Palouse country to the native grass lands and the breaks along the Snake River. This may be due to more undisturbed ground or to a natural preference for native weed seeds and insect food.

Very little specific data is at hand dealing with the food and feeding habits of the Hungarian. The nine stomachs herein summarized represent the food for the months of September, October and November. In these it is found that cereal crops furnish the greatest percentage of food, being 38.4 per cent of the total. Grass was found to be the entire feeding of some birds and the average of 24.5 per cent indicates that it is much favored. It is very probable that weed seeds and insects are more extensively taken in the spring and summer, but these investigations indicate 10.27 per cent of weed seeds and 1.21 per cent insect material.

In work done under the direction of D. J. Leffingwell, wild buckwheat (*Polygonum convolvulus*) was found to be one of the weeds most frequently taken, it alone made up 13.8 per cent

of the total food of 15 stomachs analyzed. Tarweed (*Madia racemosa*) seems to be a very desirable food plant, 2759 seeds having been taken at one feeding by a single bird. Tumbleweed (*Amaranthus graecizans*) is often taken as are burnett (*Sanguisorba annua*) and mustard (*Sisymbrium altissimum*).

The seeds of only one shrub, snowberry, have thus far been observed.

Insect material is noticeably lacking in these diets, Grasshoppers (*Orthoptera*) and ants (*Hymenoptera,* two species) were found in two stomachs.

Some complaint has been voiced against the Hungarian partridge as a disseminator of seeds of noxious weeds such as the wild morning glory. In the analyses of a number of stomachs no morning glory (*Convolvulus arvensis*) has been observed. It is highly improbable that the seeds of this species are hard enough to pass uninjured thru the digestive tracts of the bird.

The following table gives the complete summary of the food in percentage of total food of the nine Hungarians examined.

No.	Animal matter	Crop plants	Weed seed	Shrubs	Grass	Debris
1	10.	65.	3.	.....	22.	.....
2	.....	2.	.....	.....	.....	98.
3	.....	.....	1.	.....	99.	.....
4	.....	.....	62.5	2.	.....	36.5
9	.....	94.	6.	.....	.....	.....
7	.....	80.	20.	.....	.....	.....
8	.....	90.	1.	.....	.....	9.
13	1.	15.	.....	.....	.....	84.
12	.....	.....	.....	.....	100.	.....
Avg.	1.21	38.4	10.27	.2	24.6	25.27

The Ruffed Grouse

Very little material has been collected on the food habits of the ruffed grouse (*Bonsa umbellus*), a species which, for various reasons, is rapidly diminishing in numbers. Three stomachs of birds sent in to the Western division of the Grouse Investigation Committee were examined. They were found to contain fruits of the snowberry, rose and hawthorn. Some leafy material was found and a large number of catkins of willow, one stomach containing 115 of the latter.

Summary

1. Stomach contents of thirteen Ring-necked pheasants, nine Hungarian partridges, and three ruffed grouse are reported in this preliminary paper.

2. In the case of the Ring-necked pheasant, stomachs from birds in the months of October, December, January and February, show that the food of this season consists almost entirely of vegetable material, only 0.08 per cent being insect material.

3. The food of the Hungarian partridge consists of vegetable matter, 98.79 per cent, with but 1.21 per cent animal matter. These percentages are for the months of September, October and November.

4. Insufficient data prevents any generalization on the feeding habits of the ruffed grouse.

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The Distribution of Cereal Footrots in The Pacific Northwest[1]

By RODERICK SPRAGUE[2]

THIS paper discusses briefly the more prevalent footrots of cereals in the Pacific Northwest and includes notes on recent studies and field observations. It makes no attempt to include the main body of the work now being carried on by the United States Department of Agriculture with field headquarters at Corvallis, Oregon.

Footrot diseases of cereals confine their attacks to the basal portions of the plants concerned. Distinction is made between footrots and seedling blights although in some cases the same parasite may be the cause of both.

1. *The Columbia Basin footrot of wheat.*

In 1918 Dana (2) investigated various outbreaks of cereal footrots in Western Washington. The Australian wheat disease, called take-all (*Ophiobolus graminis* Sacc.), was identified in most of the diseased plots. When, therefore, a large acreage in eastern Washington near Spokane was found to harbor a serious footrot, take-all immediately was suspected of being present. Heald (3) and later McKinney (6) visited the fields near Spokane and out of this it was eventually determined that the footrot in eastern Washington was different from take-all.

Since 1919 the footrot in the Spokane area has been under investigation as a serious disease of winter wheat and barley. The trouble is found in Washington, Oregon and Idaho and may extend east to Montana.

The disease is most severe in the Grande Ronde Valley in eastern Oregon. It is also destructive locally near The Dalles on both the Oregon and Washington sides of the Columbia river. The infestation extends in the Spokane area into Idaho at least to Coeur d'Alene.

This footrot, here called the Columbia Basin footrot, is characterized by lesions in the first or second basal internode. No injury to the roots occurs. Usually the culms are only slightly stunted but the heads are frequently smaller, especially if falling occurs. The symptoms and development of the disease have been fully studied and will be given at a later date, it being beyond the purpose of this paper to go very fully into symptoms of the disease or the life history of the casual fungus.

Wojnowicia graminis (McAlp.) Sacc. and D. Sacc, *Leptosphaeria herpotrichoides De Not, Ophiobolus graminis* Sacc., Rhizoctonia sp., several species of Fusarium and an unknown sterile fungus all have been suggested orally and in print as possible primary casual organisms (4, 5, 6.) Recent work (to be published later) has reduced the list of possible casual fungi to one, namely, the unknown sterile fungus. This fungus has been called the "mouse-colored fungus" or the "mousy" fungus for want of a better name. It is always found in young lesions of the Columbia Basin footrot, but in older lesions saprophytes and weak parasites frequently crowd it out. From field and greenhouse studies it is clear that *Wojnowicia graminis* and the several types of Fusarium isolated are not

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[1] Investigations conducted cooperatively by the Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the Oregon and Washington Agricultural Experiment Stations.

[2] Assistant Pathologist, Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

Presented at the Seventh Annual Meeting, Northwest Scientific Association, Dec. 29, 1930, Spokane, Wash.

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GROUP PHOTOGRAPH OF THE OFFICERS AND MEMBERS ATTENDING THE SEVENTH ANNUAL MEETING OF THE NORTHWEST SCIENTIFIC ASSOCIATION, HELD AT SPOKANE, WN., DEC. *29 and* 30, 1930.

parasitic, at least not to any appreciable extent. On the other hand, the "mousy" fungus has proven extremely destructive in recent experimental studies. The virulence of the fungus is closely linked with environmental factors inadequately understood at present. Indications are, however, that low temperatures during the early spring or winter do not appreciably affect the development of the disease but that cool, moist growth-favoring weather does. That is, if the wheat is able to grow slowly and the fungus given sufficient moisture, disease will result readily even in the greenhouse with artificially inoculated plants and outdoors in normally infested soil. The results of detailed studies with the "mousy" fungus are given in another paper.[3]

2. *Take-all (Ophiobolus graminis Sacc.) of wheat.*

Contrasted with the Columbia Basin footrot, take-all causes a severe stunting of the affected plants and produces a general black rot of the crown and roots.

The first occurrence of take-all in this country was noted in Oregon in 1902 by Cordley (1), but it was not until Dana (2) and others began observations that the trouble was definitely worked out.

Take-all occurs in widely scattered areas in the Pacific Northwest. Some of the regions where it is now known have only recently been noted and are of interest. Take-all is probably more generally distributed in the northwest than is now thought. The places where it has been reported are as follows:

1. Western Oregon and Washington. The disease is most severe in fields on which the crops have not been properly rotated.

2. Grande Ronde Valley, Oregon. A few diseased culms were recently found by Dr. Hurley Fellows in the sandy soil near Alicel, Oregon. The Columbia Basin footrot was present and predominant in that locality.

3. Hood River County, Oregon. A few patches occur in sub-irrigated fields, as noted by Dr. Fellows and the writer during 1930.

4. Southern Idaho. Dr. Charles W. Hungerford called the writer's attention to a footrot of irrigated spring Dicklow wheat near Jerome, Idaho, during the summer of 1930. In the Pacific Northwest spring-sown wheat is usually considered safe from take-all. The symptoms resembled those of take-all except the usual semi-circular patches of stunted plants in the field tended to be elongated with the irrigation ditches. Also, according to the growers, there was no apparent connection between the presence of the disease and crop rotation practices. To cite an instance, one of the most seriously infested fields had been in alfalfa for some years. It is suggested that the irrigation water may influence the spread of the disease in spring grain. Dr. Fellows confirmed the writer's suspicion that the disease was take-all.

3. *A Footrot of Oats.*

Dana in 1919 (2) mentions a footrot of oats as being sometimes present in western Washington. Since then nothing further has been done with this and as far as the writer has been able to find, oats is supposed to be free of footrot troubles in the United States. In the Willamette valley, Oregon, there has been a mysterious disease of oats that stunts the plant, reddens the leaves and reduces the root system. The etiology of this trouble remains undemonstrated. Whether it is connected in any way with a footrot of oats found by the writer during the summer of 1930 is uncertain. The writer found a few fields of February-sown Winter Turf (Oregon Gray Winter) oats in the Alsea valley west of Corvallis that showed irregular

[3] An article bearing the title, "*Cerosporella herpatrichoides* Fron, the Cause of the Columbia Basin footrot of winter wheat," is being submitted to Science.

patches in which the plants were stunted. The lower culm nodes were covered with a black mycelial felt or stroma similar to that on wheat plants attacked by take-all but differing somewhat in that the roots seemed free of injury. The specimens were first collected rather late in the season (about the middle of June) and at that time showed a basal blackening of the stem that often extended as high as four inches above the ground line. There is always the possibility that some of the mysterious red-leaved, stunted oats were collected that were harboring a late-season saprophyte or weak parasite. There were some indications, in addition to field appearances, that this was not the case. A rapid growing, grey-brown fungus was consistently isolated from these plants. In pure cultural inoculations, in the greenhouse in the fall of 1930, this fungus was pathogenic on seedlings of wheat, oats and rye. Rink wheat, winter rye, Kanota, Winter Turf and Red Rust Proof oats were all susceptible. Of these the wheat was by far the most readily killed. The action resembled that of take-all under greenhouse conditions. The disease is found on porous, poorly tilled soil that is apparently derived from red sandstone. The fields lie in a region where the annual rainfall is approximately 90 inches. The soil is amazingly acid, one field where the disease was severe showing 4.8 ph. Field and laboratory studies are being continued.

No attempt has been made to include a discussion of the Fusaria or Helminthosporia causing footrot in the areas reported on.

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Comminution of Rock and Ore[1]

By A. H. FAHRENWALD[2]
University of Idaho

THE word comminution here refers to reduction of rock or ore by any mechanical means. It includes reduction by crushing, grinding, and by abrasion. Comminution is a relatively large industry and is world-wide. Road building, building, cement making, mining operations, and metallurgical processes embody comminution as a step in the process. Comminution machinery are rugged and expensive of first cost. The maintenance cost is high because of the necessity of frequent replacement of wearing parts which are made of expensive steels. The effort of the researcher in this field is to reduce the cost of comminution. His efforts are likely to be most fruitful when they are scientific. When fundamental principles are available, the engineer then can design machines embodying them.

Comminution may be defined as the process of making new surface. Whenever reduction is effected, new surface results.

The mechanical energy, measured in ergs, foot pounds, horse power or watts, expended in a comminution operation is proportional to the new surface produced. This is known as Rittinger's law[3] and it has been proven experimentally[4] to be correct, i. e., it is a law.

Comminuting machines for convenience may be divided into two general groups, namely, (1) those which give a positive reduction and (2) those which do not give a positive reduction. Machines of group one make relatively coarse reductions. The limit may be set at about 1-10 inch. Group one includes jaw crushers and gyratory crushers of all makes and modifications. Machines of group two include steam and gravity stamps, rolls, and all makes and modifications of ball and rod mills, or all machines requiring operation in closed circuit or in conjunction with classifiers or screens. Machines of group one effect reduction with production of relatively little surface compared to machines of class two. There is, therefore, less wear on the metal parts and less power required for a given reduction for machines of group one than for machines of group two. Comminution in the size range employing machines falling in group two is much more costly than comminution in the size range employing machines in group one. In view of the Rittinger's law above cited, the relative amounts of surface made in coarse and fine comminution are of interest.

When a cube is broken into smaller cubes, the total surfaces are inversely as the lineal dimension, i. e., $S=6\frac{1}{d}$. A 10 in. cube has 10 X 10 X 6=600 sq. in. of surface. A 10 inch cube broken into 1-inch cubes has 10 X 10 X 10 X 6=6000 sq. in. A 10 inch cube broken in 1-10 inch (about 7 mesh) cubes has 100 X 100 X 100 X 6 = 600,000 sq. in. of surface. The reduction from 10 in. to 1 in. is 10 and the new surface exposed is 6,000—600= 5400 sq. in. The reduction from 1 in. to 1-10 in. also is ten but the new surface exposed is (600,000—600= 594,000 sq. cm. The reduction is the same in both cases, but the new sur-

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[1] Presented before the Seventh Annual Meeting of the Northwest Scientific Association, Dec. 29, 1930, Spokane, Wash.

[2] Professor of Metallurgy and Ore Dressing, School of Mines, University of Idaho.

[3] von Rittinger, P. K., Lehrbach der Aufberichtungskunde, Berlin, 1867, p. 19.

[4] Grose, John, and Zimmerley, S. R., Tech. Pub. No. 46, 126, 127, A.I.M.M.E. 1928. Martin, Geoffrey, Jour. of Soc. of Chem. Ind., June 4, 1926.

face exposed is (594,000 ÷ 5400) 110 times as great in the reduction from 1 in. to 1-10 in. as from 10 in. to 1 in. In ore dressing and various mining and metallurgical operations, often grinding to -200 mesh (.0029 in.) is practiced. This is the size of opening through which all grains must pass. The average diameter of all the grains of a -200 mesh product is of the order of 5 microns or $5X10^{-3}$ mm. A gram of this size material has a tremendous total area. Experiments show that it is of the order of 5000 sq. cm. One gram of -200 mesh sand has as much area as approximately 6 lbs. of 1 in. cubes. The substance weighing 100 lbs. per cu. ft.

The number of grains produced when a cube is broken into smaller cubes is inversely as the cube of the lineal dimension, i. e., $N=\frac{1}{d^3}$.

The problem of comminution is to get the piece to be broken between two crushing faces which have back of them sufficient energy to break the pieces. For coarse comminution this can be done between two faces (jaws) which are caused alternately to approach and recede from each other. In fine comminution for a given weight of material there is a tremendous number of small pieces which must be individually crushed. This situation requires a crushing environment giving a large number of contacts in a small unit of time. This condition is effectively realized in machines of group two of which the ball mill is the outstanding example.

In a crushing machine there are two questions of prime importance to the operator, namely, (1) capacity, and (2) efficiency. By capacity is meant the number of tons of rock per hour the machine is capable of reducing from a given size to another specified smaller size. The reduction in one pass through machines of group one ranges from 2 to 1, to 10 to 1. The method by which efficiency of these machines may be improved that is of greatest promise is the use of antifriction bearings. The employment of antifriction bearings in rock crushers calls for a modification in operating principle. The total displacement of the reciprocating part should be decreased and the number of strokes per unit of time increased. These new ideas in crusher design have been developed by the writer at Moscow and are embodied in a new type crusher now in process of development. S.K.F. spherical roller bearings are being employed. They have a load rating of from 60,000 lbs. to 100,000 lbs.

In machines of group two, and referring here particularly to the ball mill type, a great many factors are involved. The ball mill is a grinding machine comprising in its simplest form a rotatable cylinder of steel, lined with heavy steel blocks to take wear. The cylinder is closed with disc, conical, or other shaped ends. These ends are provided with hollow bearings (trunnions) upon which the steel cylinder is carried and rotated, and through which feed is admitted and ground material discharged. The shape of the inside of the mill probably has only little bearing on the capacity or efficiency of the mill. The steel cylinder, called a mill, is loaded with balls or pebbles or other media and rotated. The factors of importance determining capacity and efficiency of the mill are:

I The Mill; (1) Diameter, (2) Length, (3) Speed of rotation.

II Crushing media; (1) Size of ball, (2) Per cent of mill volume occupied.

III Feed: (1) Size of feed grains, (2) Volume of feed related to ball load and size.

IV Void Medium; (1) Ratio of water to feed grain surface.

The task of studying ball mills with the purpose in view of improving their performance is an exceedingly difficult one. It is difficult not only in

that many dependent variables are involved, but a scientific basis of gauging ball and mill performance is difficult to establish. For rough, preliminary work, when grinding is not too fine, and when only output is considered, relative mill performance may be stated on the basis of a sizing analysis using sieves. Excellent sieves are available down to as fine as 400 mesh (.0014 in.)

One, however, does not get far into the study of fine grinding in ball mills before he finds the almost absolute need of a method of stating the efficiency of mill performance in absolute units. In view of Rittinger's law, the absolute efficiency of a grinding operation is the surface produced times the surface energy of the material crushed times 100 divided by the useful energy put into agitating the balls in the mill. The energy input does not include that necessary to turn the mill in its bearings when loaded with a centered dead load equal to that of the balls. The energy input to the mill can be measured with reliable accuracy. The new surface resulting in the crushing operation is a datum exceedingly difficult to obtain with acceptable accuracy. The methods used for obtaining surface data of fine sand are:

1) Sizing with sieves and by elutriation with water, counting grains and employing a shape factor and Stokes law.

2) With the microscope, determining the average diameter, counting the grains and employing a shape factor.

3) One in conjunction with predetermined surface data.

4) Methods based on adsorption of ions or molecules and resultant changes in such properties of the solution as surface tension, -ion concentration, electrical conduction, color, etc.

5) Disolution method based on Wensel's law, which states that the rate of solution of a solid in a solvent is proportional to the total surface.

Methods 1, 2, 3, and 4 give surface of approximate magnitude only. Method of surface determinations, using fair reliability for some substance such as quartz. The accuracy of this method on grains approaching molecular size is questioned. It was by this method of surface determinations using quartz, that Rittinger's law was definitely proven. The method is not available for many substances and, of Course, on ores it is useless because of the different solubility properties of the various constituents present.

Method 4 has not been sufficiently investigated. Interfaces are electrically charged which is proof of ion adsorption. The sign of the charge is determined by the nature of the solid surface and the ions in the water. The accuracy of this method depends upon the assumption that the adsorbed ions always are one ion deep and upon the accuracy with which change in ion concentration in a water solution can be measured. We have obtained some very promising results with this method in our laboratories at Moscow.

Now, given a method of accurately obtaining surface, the next requirement is a surface energy for the material in question. Surface energy data for many solids are not easy to find, and those available are probably only order of magnitude values. One scientist employing van der Waal's equation, the density and cubical expansion, obtained for quartz a surface energy value of 920 ergs. Another scientist making the assumption that the work required to reduce quartz sand to the size of gas molecules would be the same as that required to convert silica to a gas, obtained a surface energy value of 510 ergs. Using these data, various investigators of crushing phenomena have obtained efficiency values for ball mills of the order of one per cent.

Gross and Zimmerley, using quartz and a drop weight method of crushing, found that a kilogram-centimeter of work produced 17.56 sq. cm. of new quartz surface. New surface was determined by the hydrofluoric acid dissolution method. Taking 920 ergs for the surface energy of quartz, these data gave an efficiency of 3 per cent.

Assuming that efficiency data calculated by the above method are of order of magnitude correctness, it is concluded that only a small fraction of the energy required to operate a crushing machine is accounted for in the form of new surface. On the assumption that the input energy, measured by a wattmeter, in a crushing operation is used in producing heat, new surface and sound vibrations—and the latter may be ignored—a method of calculating the efficiency of a ball mill on basis of thermal measurements may be worked out. Such a method has been developed in our laboratories at Moscow. Efficiency data of a laboratory ball mill by the thermal method have been obtained as high as 25 per cent.

The technique of this method involves a knowledge of the thermal capacaties of the elements of the mill which include steel, rock, and water; accurate measurement of power input to the mill; accurate measurement of the change in temperature of the system over a known period of time. The apparent energy equation then in its simplest form is as follows:

$$W = SnE + (t + \Delta t)\ TJ$$

Where w = energy input as indicated by a wattmeter
S = new surface formed
E = surface energy
t = measured rise in temperature of system
Δt = heat lost to surroundings
T = thermal capacity of the system
J = Mechanical equivalent of heat

The efficiency of the operation is:

$$E = \frac{w - (t + \Delta t)\ TJ}{w} \times 100$$

If there were no other elements involved, the above equation would enable us to calculate efficiency data and if we could measure surface accurately, this equation also would permit us to calculate the surface energy value, E, of the substance being crushed. This is being undertaken in our laboratories at Moscow.

The above energy equation is, however, not rigorous. At least, three other items that are heat-producing or heat absorbing must be taken into account, namely, (1) the heat of solution of quartz in water, (2) the cooling effect as a result of creation of new surface (similar to expansion of a gas, i.e., evaporation), and (3) the heat of wetting of the new surface formed. A more complete equation is:

$$W = S_n E + [t_f - (t_s + (-t_e) + tw]\ TJ$$

Where t_s = heat of solution of quartz
$(-t_e)$ = heat of expansion (cooling)
t_w = heat of wetting

It is the sum of t_f, t_s, $(-t_e)$ and t_w that is measured with the thermometer, t_f being heat due to friction. What we want is t_f. Undoubtedly t_s is a neglibile quantity because the charge of sand and surface exposed before starting the grind is sufficient for complete saturation of silica in water; t_e is a small quantity and would introduce an error of not more than one per cent; t_w, the heat wetting of water, is apparently a relatively large item being given as .00105 cal/sq. cm. for quartz. Converting this figure to ergs, the energy involved in the wetting

of 1 sq. cm. of surface is (4.80 x 10^7 x .00105) = 41,800 ergs. This is 41800 ÷ 920 = roughly 45 times as great as the energy required to create 1 sq. cm. of quartz surface. The adhesion between water and quartz is tremendous. It is given by Nutting[5] as 17,000 atmospheres. This is about the tensile strength of quartz.

The thermal method can give only relative efficiencies in the absence of a definite knowledge of the heat of wetting of the substance crushed. We have obtained by this method ball mill efficiencies as high as 25 per cent. If the heat of wetting is a positive value of any magnitude, our efficiency data are too low. Thus, it would appear that the efficiency of ball mill grinding is well up toward 100 per cent and that the available surface energy data for quartz are many times too small.

Further progress in fine grinding studies is much dependent upon accurate methods of determining absolute efficiencies.

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The Chemical Utilization of Wood[1]

By E. C. JAHN, University of Idaho

This paper outlines briefly some of the more important considerations concerning forest chemistry, namely: What forest chemistry involves, the value and necessity of chemical research on wood, and past achievements and future possibilities in the chemical utilization of wood.

As an introduction to the major premise, the chemical components of wood are covered in a cursory manner. . . . . Wood is divided chemically into four major groups, none of which is clearly defined. They are cellulose, lignin, the polysaccharides, and the extraneous components. Cellulose and lignin are the two principal components making up about 50-60% and about 25-30%, respectively, of the wood.

There are two broad problems which are the goal of forest chemists: (1) those which deal with the chemical mechanism of tree growth and with the chemical constitution of the substances formed during growth, and (2) those concerned with the chemical utilization of the forest crop and forest wastes. It is particularly in regard to this latter problem that this paper is developed.

Among some of the economic and practical reasons why research on the chemical utilization of wood is essential are:

(1) The obvious advantages of wood as a cellulose producer over the annual agricultural plants.

(2) The necessity of increasing our forest values.

(3) The utilization of our vast amounts of waste wood and species uneconomically suited for lumber.

The advantages of wood as a cellulose producer are: (a) The character and quality of the fiber which enable its use in diverse industries such as high grade paper and artificial silk. (b) Compactness which is of importance in transportation, storage, and handling. (c) No forced annual harvesting. (d) Wood can be grown and harvested on a large scale, the transactions passing through but few hands. (e) The greater yield of cellulose from trees. (f) The great amounts of wood waste and mill waste at hand waiting to be used.

Perhaps the outstanding reason why research on the chemical utilization of wood is a necessity is because it is

[1] An abstract of the paper presented before the Annual Meeting of the Northwest Scientific Association, December 29, 30, 1930, Spokane, Wash.

essential to increase our forest values by extending the number of useful products obtained from wood, and by using our present day enormous quantities of waste raw material. There is about 50% waste of the log which comes to the sawmill. Furthermore there is appreciable loss in the woods. Then there are the large stands of species which are not suited for lumber under present economic conditions.

Utilization of this potential raw material by chemical methods would mean greatly increased forest values brought about by the extension of the number of useful products obtainable from wood. An ideal situation would be to use large, sound trees for lumber, and to use smaller and inferior trees and uneconomically suited species together with mill waste for the manufacture of products chemically.

What are some of the lines that chemical research should follow, and what are some of the possibilities?

Research in wood chemistry should be directed to the utilization of our vast quantities of wood waste in as near a 100% manner as possible.

The major problem, then, is to convert by cheap means our large amounts of waste wood, uneconomic species, etc., into products producable in good yield and which will have a wide market. To do this we must look for fundamental basic products commanding wide demand in our larger industries. Also we must improve such basic products from wood as we already have, such as paper, insulating and wall boards for the building industries, vulcanized fiber products for the automotive and electrical industries, cellulose products for the artificial silk, cellophane, explosive and varnish industries, and raw materials for the chemical industries such as are supplied by wood distillation.

A discussion of some of the outstanding chemical wood utilization problems includes the synthetic lumber and fiber board industry, new methods for destructively distilling wood to obtain new products including motor fuels, sugar and alcohol production, industrial fermentations for commercial organic chemicals, and lignin.

It is interesting to note that new destructive distillation processes have been experimented with which hold forth considerable promise. One method will convert 90% of the wood into volatile products, principally phenols and unsaturated hydrocarbons.

Other problems pertinent to the wood chemist are discussed and it is indicated that the future industrial development of chemical wood industries will be large.

It is problems such as these which are being studied and planned at the Idaho School of Forestry.

The work of the Forest Products Laboratory of the School was expanded this year to carry on studies in wood chemistry. Investigations will be carried out on new and improved methods of pulping wood wastes and the conversion of the pulp into suitable products. New and broader uses for fiber board, molded products, and synthetic lumber are being sought. Two of the most important problems in this connection are water and fire proofing. The usefulness of a successful and cheap fire-resistant product speaks for itself. One of the outstanding properties of cellulose is its affinity for water. A cheap means of overcoming this factor would vastly improve fiber board products, eliminating swelling and humidity deformations, as well as to a large extent, decay.

Lignin will also receive attention from the fundamental as well as the technical side. This is part of the program of work at present.

By quiet research this laboratory hopes to contribute to our fund of knowledge concerning wood, and through this knowledge to new and useful products.

Benzoic Acid Content of Western Grown Cranberries[1]

By R. P. COPE and HOWARD J. STRAUCH
State College of Washington

THE production of cranberries on the Pacific coast of southwestern Washington has become an important industry. The crop of 1929 amounted to 60,000 boxes valued at nearly $300,000, and met with a big demand from the fruit dealers. The commercial berries grown on the western coast are larger, have thinner skins and less color than the eastern product and the pulp of the berry seems to have a finer texture, to be less firm and not so tart. This variation in the appearance and condition must be the result of climatic or soil influences because the western plants were originally brought from the bogs along the Atlantic seaboard. The chemical composition of the Washington berries has never been determined so that they cannot be compared with the eastern berries in that respect. It is our intention, however, to examine the next crop for the usual chemical constituents and to study the break-down during the period they are held in storage.

Our interest in the cranberries came about as the resu't of the examination of fruits and foods for the presence of chemical preservatives. Cranberries were known to contain the more or less common preservative, benzoic acid. Accordingly, a sample of western berries of the crop of 1929 was provided for class work, and the usual positive test for the acid obtained. The question then arose as to the amount of this acid contained in the berries from the western bogs. As this had never been determined it was decided to obtain a sample of the 1930 crop of berries from the branch Experiment Station near Illwaco, Washington, and determine the benzoic acid content. The superintendent of the Cranberry Investigation Laboratory, Mr. D. J. Crowley, kindly supplied us with a sample of the most important commercial variety this fall and the benzoic acid content has been determined by the usual method. The fruit is macerated with sodium chloride crystals in a mortar, then the benzoic acid is salted out from the pulp with a saturated brine in an alkaline solution. After standing four hours the pulp is filtered off, washed and discarded. The filtrate is acidified and the free benzoic acid extracted with five or six portions of chloroform. Upon evaporation of the chloroform a crystalline residue of the acid is obtained, which is then dissolved in neutral alcohol and titrated with N/20 base.

The benzoic acid content of a commercial variety of eastern berries was determined along with the analysis of our western fruit. The benzoic acid content was found to be exactly the same for the berries from each seaboard, as shown by the following table:

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[1] Presented before the Seventh Annual Meeting, Northwest Scientific Association, Dec. 29, 1930, Spokane, Wash.

Where Grown	West Coast	East Coast
Most Important Commercial Variety	McFarlin	Howes
Benzoic Acid Content	.064%	.064%
Sodium Benzoate Equivalent	.076%	.076%

It is evident that if a variation in the chemical composition of the berries exists it is not in the benzoic acid content. However, as it is an established fact that the same variety of fruit grown in various parts of the country differs somewhat in chemical composition, it is expected that a variation in the crude fiber, sugar, starch, pH, acidity, ether extract, protein, ash, or moisture content of cranberries will be found.

The identification of benzoic acid in the residue obtained from the chloroform extract can be easily carried out in a very impressive manner. The residue is dissolved in a few drops of chloroform, transfered to a test tube, and the solvent evaporated. A side-arm test tube of a slightly smaller diameter is inserted into the test tube containing the residue and a stream of cold water run thru the inner tube. This couses the benzoic acid to sublime and collect in large, beautiful, characteristic needle-shaped crystals on the cold surface of the inner tube. The crystals may be easily removed and their melting point determined for positive identification. This method may be used for the determination of benzoic acid in the extract from any fruit or food.

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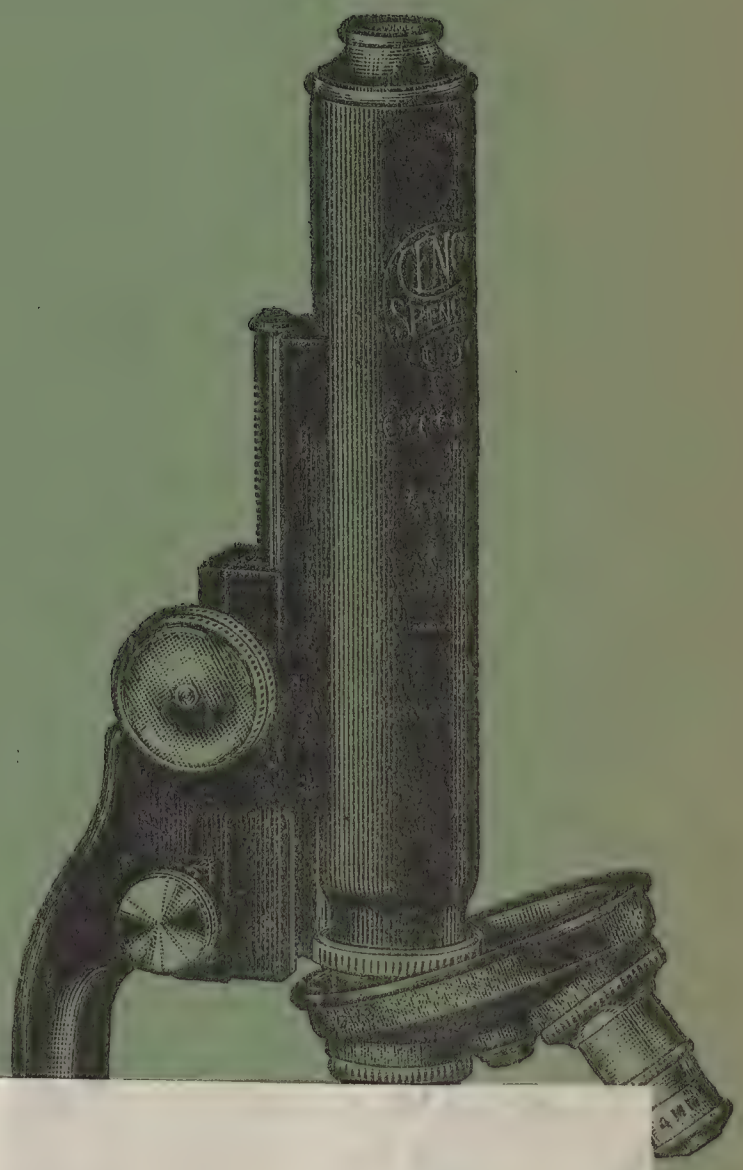

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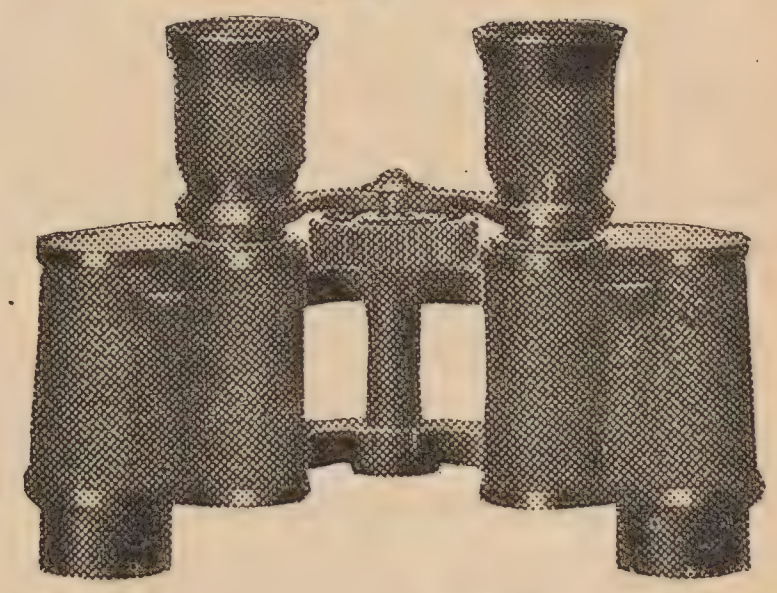

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The Present and Future Role of the Airplane In Forestry[1]

By

HOWARD R. FLINT

U. S. Forest Service, Missoula, Mont.

MODERN man no less than his aboriginal predecessors is prone to seek miracles when his need is urgent. At such times it appears to be a common trait of human nature to turn to the sorcerer most popular at the moment and demand of him the particular kind of miracle that is needed for the emergency. As human achievement is measured it was not long after the Wright Brothers' original triumph in the atmosphere until people began to demand out of the success the fulfillment of a host of needs that had long been truoblesome problems.

It is reported on authority which the writer believes reliable that one or more hydroplanes were used in Wisconsin for the detection and reporting of forest fires in 1912-'15. More urgent need brought the airplane permanently into forestry in 1919, shortly after its return from the battle-fields of Europe. At any rate the writer has been unable to find authentic report or record of its use in forestry prior to the occasions mentioned above.

The Canadian Government, at the close of the World War, found itself with a staggering forest fire problem in a vast undeveloped region. Its force of skilled forest protection men, never before adequate to the task, had been depleted. Those in authority turned to the sorcerers, in this case a highly developed, and for that time, well equipped air force made up of militant crusaders eager for fresh hosts to conquer. Pioneering in a new field they made, during that season, many flights over the vast wilderness of the Canadian forests.[1] Official reports of their activities indicate that their miracles, other than the very real one of performing successful flight, were not of a startling nature, nevertheless they were able to achieve some degree of success in discovering and quickly reporting fires. In subsequent seasons vast areas in Canada were mapped by means of aerial photography and extensive timber estimates were made rapidly and with minimum effort.

During the year 1929, forest pretection and suvey work were continued in the Dominion on a larger scale than ever before. The Canadian official report for 1929 says in part, "millions of acres of our remote forest areas,

[1]Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 29, 30, 1930, Spokane, Wash.

hitherto unprotected because of their inaccessibility, are now efficiently patrolled. Their extent and value have been determined. Adequate maps, the first essentials of any development, can now be made with speed and accuracy undreamt of before the advent of the aeroplane."[2]

Aerial forest patrol in the United States was first regularly begun in the National Forests of California in 1920. It was carried on with Army personnel and equipment during the seasons of 1921 and 1922, and then discontinued for lack of funds until 1925. It was then undertaken as a United States Forest Service activity in the Pacific Coast States, Montana and Idaho with equipment loaned by the Army and personnel hired by the Forest Service. Beginning with the 1928 season the use of Army equipment was discontinued, bids were called for and the flying was contracted to commercial organizations.

During the six seasons ending with 1930, two planes have been available during the fire danger season for forest patrol in the Northern Rocky Mountain Region under one or the other of the plans mentioned in the foregoing paragraph. One or more experienced Forest officers have been assigned to the patrol each season. The planes have flflown in six seasons a little more than 1500 hours on forest work. They have been used primarily for the detection and reporting of small fires, principally lightning-caused fires, in areas not adequately covered by forest fire lookouts. To a less extent they have been used also for the scouting of large fires, for the transport of men in supervisory positions, for photographic and sketch mapping. They have been used in a very limited way for the transport of urgently needed items of equipment and supplies; for preliminary forest insect reconnaissance and as an auxiliary in land and timber reconnaissance.

In the detection and reporting of small fires the planes have been found especially useful for checking up after lightning storms on areas known to be invisible or inadequately visible to ground forces. Fires in such places are particularly dangerous in that they frequently reach considerable size before they are seen by ground forces and have then become difficult and costly to control. Forest Supervisors' reports credit the planes with first reports on twenty-four such fires during the five years ending with 1929. This is a small number of fires but it must be remembered that the planes have worked in competition with from 250 to more than 300 well established and equipped lookouts stationed on the most commanding vantage points of the region. These lookouts, maintained at a cost of more than $150,000 per year, are perhaps, the most potent single factor in fire control in the region. They have discovered 42% of the total number of fires, the remainder being first seen by other Forest employees, co-operators and users. In 1929, a year with an exceptional number of fires, the lookouts gave first report on 752 fires, an average of a little less than 3 fires each, the remaining fires being discovered by other observers. In the light of these data the performance of the planse seems fairly successful.

In scouting larger fires the planes have given helpful information, progress maps and direction more quickly than any other means could have done on more than two hundred fires. At times this assistance has been of great value. It is as impossible to reduce it to definite terms of dollars and cents as it is most of the other savings effected by fire control. No one can predict with even a moderate degree of accuracy what losses might have been in the absence of any specified control effort or of all effort.

Transport of men and equipment to going fires has barely started in the

United States. Some of the earliest efforts have been made in the Northern Rocky Mountain region. In one instance during the extreme forest fire emergency of 1929, twelve forest officers experienced in fire suppression were moved from Arizona to Kalispell, Montana, in a single day by means of a tri-motored transport plane. This method of transportation made them available for duty on fires at least 36 hours quicker than any other method could have done. The principal reasons for slow progress in this direction have been, in the order named:

1. Lack of safe landing fields in the forested areas.

2. Scarcity of planes adapted to transport work.

3. High cost of aerial transport.

The obstacle first listed above is inherent to the region and is the most difficult of all to overcome. That is true becouse of the extreme ruggedness of the terrain in the mountain forests of Idaho and Montana. There are at best only a few places in the forests of the region that have sufficient areas of level or near-level ground to afford a safe field for a transport plane. The existing suitable areas all require more or less cash outlay for acquisition, clearing and surfacing before they can be used. Large lakes are too few in number to warrant operation of a seaplane. Some measure of success has been attained in dropping urgently needed articles of supplies and equipment from planes in the air to ground forces. Gasoline, hose and repairs for fire pumps have been successfully so delivered and in one or two instances food supplies and blankets. Canadian foresters, beginning in 1920, have made considerable use of relative large sea planes for transport, landing on some of the hundreds of lakes which are found in their forests.[3]

There has been in the region a small, but increasing use of airplanes for the ordinary travel of Forest officers. In some of the longer trips, and in trips where ground routes are circuitous the saving in time is sometimes very great. It seems inevitable that this sort of use of airplanes will continue and increase.

In forest utilization, airplanes are already definitely in the picture in connection with the recreational use of forest areas remote from civilization. At least three comercial aerial transport organizations in the Northern Rocky Mountain region have initiated and carried on for two or more seasons the business of transporting fishermen and hunters into territory hitherto eploited only by means of saddle and pack horses. This line of business is growing directly in proportion to the increase in the number if useable transport landing fields in areas not tapped by roads. It is already a live problem of serious importance in the administration of the so-called primitive or wilderness areas.

Rather indirectly connected with the use of airplanes for transport over the forests is their role as a source of forest fires. It is of record that fires have been started by burning material dropped or thrown from passing airplanes. Experiments conducted by the aerial forest patrol in the Northern Rocky Mountain region prove conclusively that a large percentage of cigar or cigarette butts thrown from passing planes may be burning when they reach the ground and, consequently, may under suitable conditions, start forest fires. It is, of course, unneccessary and unlawful to throw burning material from planes.[4]

Airplanes have been used experimentally in this region to a very limited extent for scouting areas of bark beetle infestation in large tracts of coniferous timber. For extensive work over large slow travel areas the method is one of considerable promise. Given good base maps and a skilled observer it is certain that fairly detailed mapping of

infested areas can be done at any time after the foliage of the trees has faded to a marked degree. The use of the plane for this purpose has not thus far given results of great or unusual value. Areas of moderate or heavy spruce bud worm infestation are easily seen and mapped from the air after the work of the insect is well under way. Fitted with suitably designed traps, airplanes have been used by forest entomologists for the study of insect migration and occurrence in the upper air. Such studies have already yielded valuable information on a subject about which but little is known.

In the eastern United States some experiments have been made in the control of forest and orchard defoliating insects by dusting with poisons, usually arsenic or lead compounds distributed to the foliage from a low flying plane. One such experiment in Wisconsin dealing with a common and usually not dangerous defoliator, *Ellopia fiscellaria* which suddenly became epidemic in Peninsula State Park is reported to have been successful on an area of 715 acres. Calcium arsenate dust was applied at the rate of 20 pounds per acre with an apparent mortality of 60-95 per cent of the larvae.[5]

In Canada both extensive and intensive experiments with control of both spruce bud worm and hemlock looper have been conducted, the experiments extending over several seasons. Results indicate that this form of defoliator control is possible under favorable conditions. It seems at present too costly for general application and there is still room for much improvement in equipment, technic and dust poisons for this purpose.[6]

It is reported that some 3500 acres of oak forest near Minden, Germany, was dusted in the spring of 1926 using calcium arsenate to combat a defoliator. The woods were almost cleared of insects in a short time. However, severe losses resulted among game animals and birds. Great numbers of bees were killed and some domestic animals affected. In other localities similar losses were not noted after dusting with arsenic from a plane.[7]

In Canada during the year 1925, some studies of plant epidemiology were undertaken by means of the airplane. The movement and dissemination of the spores of the black stem rust of wheat in the upper air was studied by exposing coated slides at various altitudes. Control measures were undertaken, with some promise of ultimate success, by dusting with finely ground sulphur.[8]

The writer has no record of planes used in the United States for a study of the movement of White Pine Blister Rust spores but is under the impression that some experiments of that kind have been conducted.

Airplanes have been used in a limited way in the Northern Rocky Mountain Region and elsewhere for the dissemination of grass seed and forest tree seed on denuded areas. A tract of cut-over land in Idaho belonging to the McGoldrick Lumber Company was seeded to forage grasses following the forest fires of 1929. No report on germination and growth from this project is available at this writing. A similar project covering 1000 acres in Coos County, Oregon, has been definitely reported as a success.[9]

At least one experiment in sowing seeds of forest trees from an airplane has been reported. A burned area of 700 acres on the island of Oahu, Hawaian Islands, was seeded from a plane in July 1926. The seed was reported as well distributed but no report on its growth is available to the writer at this time.[10]

Large scale experiments with aerial photographic mapping of forest areas have been conducted during the past four years in the Northern Rocky Mountain region with mose encourag-

ing results. More than 600 square miles of National Forests have been photographed on a scale of about 6 inches to the mile. Pictures so obtained may be indexed on any available map and individually taken to the field for use; they may be compiled into a useful mosaic or composite picture of a large area; or, an intensive line map to any desired scale may be made from them. All three methods have been tried to a sufficient extent to demonstrate some of their possibilities. None of the possibilities have been by any means exhausted. In fact they have been but barely scratched.

Vertical aerial photographs have some inherant advantages over map data secured by other methods. Every exposed detail of the terrain covered is faithfully recorded. In addition to terrain, major features of culture and of vegetative cover are registered in a detail and completeness impractical by any known ground method. A ground surveyor sees and records only those details immediately adjacent to his line of travel, areas between courses are necessarily more or less slighted. Consider, for example, the work involved in mapping by ground survey methods, the relative position of each tree, directly visible from above, on a square mile of mountain terrain. If growing in the open, coniferous trees 6 to 8 feet in height are plainly visible in a good photograph taken from 10,000 feet above. Sixty or more such square miles can be photographed in a day. In addition to trees, each vertically exposed clump of brush, each opening in a timber stand, the outline of each burnt area, each widely divergent age class, and each contrasting major cover type is clearly revealed in a good photograph and may be transferred to a map with a degree of accuracy sufficient for any of the ordinary needs of a forest manager.

Aerial photographs show in great detail roads, buildings, clearings, drainage, stream, lakes, swamps and general character of vegetative cover. Placed two in series under a simple and cheaply constructed steroscope they can be made to show relief, perhaps more completely and faithfully than the best relief map shows it. So distinctly is relief brought out under the stereoscope that the figure of a tree photographed from two miles above appears to stand up distinctly a quarter to one-half inch above the surface of the paper and to cast a shadow.[1] A series of such pictures, properly catalogued and indexed on a map will constitute a veritable treasure room of information in regard to any area which they cover.

Aerial photographic mapping is now duly recognized as an important method and is used by the United States Geological Survey, the United States Army, and several private engineering organizations in the United States. In Canada the method has long been in use on a large scale and many thousands of square miles of Canada's forests have been mapped or are in the process of being mapped by this method.

In extensive areas badly mapped or but little explored, valuable data can be quickly secured by a skilled observer sketching details from an airplane. Major Scott, Deputy Conservator of Forests, of Burma, in an address to the Forest School of the Phillippine Islands says that in 1925 an intensive cover map of 15,000 square miles of tropical forest was made by sketching in types on a 1 inch to the mile base. This project was a great success. The mapping was checked by photography, by cruising on the ground, and by sketching by an independent observer and found sufficiently accurate for all practical purposes. Twelve forest types were distinguished. The work was done at the rate of about 230 square miles per hour.[12]

Radio has not been used on forest patrol planes in the United States to

date because of imperfections in aerial radio apparatus, its lack of reliability, and lack of adequate receiving and relaying equipment on the ground. Much research is being done by the Army and commercial organizations on radio for airplanes, and foresters are watching it with interest and expectation.

The present day cost of flying is high. For the forest patrol it has averaged about $42 per hour of actual flying time. Oddly enough it has been about the same whether Army or privately owned planes were used. The Army planes were old, heavy and expensive to operate. If maintenance, ordinary depreciation and crash losses are fairly considered it is known that contractors who have flown the forest patrol have not realized great profits from the enterprise as conducted in the Northern Rocky Mountain Region by commercial fliers with modern equipment. The trend of the cost of flying is downward but not rapidly downward.

Fifteen hundred-odd hours of forest patrol flying in this region have been completed without loss of life on the job. Three men have suffered minor injuries. There have been a number of escapes, more or less narrow, real but not made a matter of record. One plane has been demolished in a crash on forest patrol and another on transport work. It may or may not be significant that two of the eight experienced and highly skilled pilots who have flown the patrol have been killed in crashes while flying on other projects. Flying is yearly becoming less and less dangerous. It is still a hazardous occupation.

The foregoing paragraphs deal with the history of the airplane in forestry, chiefly on this continent. They are matters of fact and record tinged by but very little expression of opinion and no prediction or speculation in regard to the future. Perhaps a paper of this kind would seem scarcely complete unless it recorded some prediction in regard to future possibilities of the airplane in forestry.

Aviation in forestry has suffered from the bad effects of exaggerated claims. The airplane cannot supplant ground forces in fire control or in insect control. It can and will render them considerable valuable assistance. In the writer's opinion, aerial methods of mapping will not supplant ground surveying but the time seems not far distant when no large or important forest survey will be made by ground methods alone.

Possibly the extreme of optimistic views in regard to the future of the airplane in forestry is that expressed by Mr. Erle Kauffman, a forester, and assistant editor of American Forests and Forest Life, in which he foresees; a public made fire-conscious, fires more promptly discovered than ever before, men and equipment in quantities quickly moved by huge transport planes, insect infested areas dusted, timber surveys simplified, census of big game animals accurately and quickly taken, streams stocked with fish; all by safe planes which virtually fly themselves and which remain in constant contact with ground forces by means of radio.[13]

While the predictions cited in the foregoing paragraph are far from actual achievement to-day they are, perhaps, not wilder than would have seemed a prediction made 20 years ago to the effect that automobiles and trucks would soon become the backbone of transportation in the mountain regions of the West. It is not neccessarily true that the future of air transport will run parallel to the history of motor transport, neither is it unreasonable to expect that there will be considerable similarity in the two lines. A statement of any forecast in regard to its usefulness may well include some consideration of

the present and future development of the airplane itself.

The ordinary commercial airplanes of to-day have speed. In still air at altitudes up to 10,000 feet above sea they are capable of from 85 to 110 miles an hour. Average cruising speed is about 90 miles per hour. Special planes are now available commercially for practical use, which are capable of about twice that speed. In still air, at 5,000 feet or more above sea, with a moderate load, the writer has found the ordinary planes incapable of maintaining altitude at less than about 65 miles per hour. They must attain about that speed before they will commence to leave the ground. They cannot be landed in still air with a moderate load on the high-lying fields of this region at less than about 50 miles per hour.

High speed is one of the principal arguments advanced in favor of the airplane. Inherent lack of ability to fly and remain in control without relatively high speed is one of its greatest weaknesses from a forester's viewpoint. If planes could descend and rise vertically or nearly so, under full control, one of the chief dangers of flight would not exist and there would be no need for large landing fields with clean approaches. If a plane could be held in full control at a speed of 20 miles an hour or less there would be ample time for the aerial observer to study the location and behavior of a fire, sketch it accurately on his map, photograph it and communicate conveniently with ground forces if he so desired.

Unfortunately the advantages named above seem unlikely to arrive for practical use in the immediate future. The best that has been done with experimental aircraft of proved design is a landing speed of about 36 miles per hour at sea-level under ideal conditions. This plane was specially designed for safety and won a $100,000 prize in October, 1929, in a contest for safety which was international in scope. Although it had a high degree of sfaety, this plane, for some reason unknown to the writer, has not been placed on the market.

Another special type of plane designed for safe flying is the Cierva autogiro; invented by a Spanish aeronautical engineer. The plane is unique in that a considerable part of the wing area is in the form of vanes somewhat resembling those of a Dutch windmill. These vanes, on long arms, are set in a horizontal plane above the vertical axis of the fuselage of the plane and rotate freely in flight. Their vertical lift and stabilizing influence makes it possible for the plane to rise or descend almost vertically, perhaps within about 15 degrees of the vertical, within full control. The rate of descent with an ordinary load is said to be about 14 feet per second and the horizontal landing speed only a few miles per hour. It has landed and taken off safely from very small areas. American rights for the manufacture of this plane have been purchased by a leading American builder of airplanes and several experimental machines are said to have been built and flown in this country. Whether this type will prove practical for mountain and forest flying remains to be determined. It seems to hold forth considerable promise for such work as scouting forest fires and insect infestations and for dusting for insect and disease control.

None of the stock model airplanes used for forest patrol to-day are ideally adapted to the job even if present practical limitations are accepted for the purpose of fixing a standard. Most or all of those in use are open, rigid seat biplanes with about 200 horse power. From the standpoint of visibility and minimum "blind area" the ideal plane would be an open, two-place high-wing monoplane of 300 horse power with observer seated on an adjustable revolving stool in a long and deep, but not too wide, rear cockpit.

The plane should have the lowest possible stalling speed and should be capable of work at a 16,000 foot ceiling with at least 400 pounds pay load. It should have a cruising range of 6 hours and should be adapted to aerial photographic mapping. It should be fully equipped with high class altimeter, air speed indicator, and compass, in both cockpits and with the other accepted instruments on the pilot's instrument panel. Removable dual control is desirable.

Possibly the new Diesel airplane engine which eliminates carburetors, ignition suystem and fire danger will prove practical and desirable. Dual motors, either of them capable of sustaining the plane in flight, would be desirable, but no suitable plane so equipped is available today.

The possibility of using blimps or small, dirigible, lighter than air craft for work over the forests has often been broached and considered. In many ways, this sort of craft would seem ideally suited to forest work. Unfortunately it is very expensive to build and to operate. Several years ago an experimental flight was made with a blimp over one of the forests of California. The result was discouraging. In 1930 a small airship or blimp was used in a survey of a portion of the Everglades in Florida with a view to determining the suitability of the area for National Park purposes. Probably airships are much better suited for work in that sort of country than for mountain work.

As designed at present it is difficult to get such a craft much higher than 6,000 feet above sea level with any load. To attain great altitude it is necessary to valve out gas for the purpose of avoiding excessive pressure in the gasbags. When that is done the dirigible loses some of its lifting power and its usefulness decreases. It does not behave well in boisterous or fickle winds such as are often developed in "line squalls" and thunderstorms. It is not impossible that some or all of these disadvantages may be overcome in future design, but the present outlook seems not very bright and it is improbable that lighter than air craft will be available for foresters' use within the next five years.

Considreing the fact that any part of an area with a radius of 175 miles can be reached by a transport plane in two hours' flight from a base at the center it appears that the use of planes for immediate transport of men and equipment to going fires has received and is still receiving insufficient consideration. Wherever level, firm ground in an area a half mile long in the direction of the prevailing summer wind and 400 feet wide, having unobstructed approaches from either end, is available a transport airplane field can be cleared for the cost of constructing one to three miles of mountain road suitable for use by heavy trucks. Once properly constructed the cost of maintaining such a field is negligible and in most cases it will furnish good pasture or hay land without seriously interfering with its use for fire control aviation.

No special funds have ever been provided by Congress for the preparation of such fields in the National Forests. Small balances saved by rigid economy in the use of the air patrol have been used with the result that it is expected that 6 fields of minimum requirements for transport use will be in service by July 1, 1931, in some of the more remote forest areas of the Northern Rocky Mountain region. Five or six times that number of such fields could be used to advantage if suitable areas can be found and developed. They would greatly speed up action on fires and eliminate the need for many miles of costly roads. This use of airplanes in forest fire control seems a most promising one and may logically be expected to grow to considerable impor-

tance during the next few years if foresters are alert and capable in taking advantage of it.

Probably one of the most promising immediate fields for the use of the airplane in forestry is in aerial photographic mapping. Experimental progress in this method of making maps for many purposes is rapid and is most promising in results. Some of the actual achievements have so much the appearance of magic that one hesitates to quote them. For example Mac Ready and Stevens, of the U. S. Army, photographed the city of Dayton, Ohio, in May, 1924, from an altitude of more than 31,000 feet, securing a picture which shows the plan of the city and minor detail so clearly that it reproduced plainly as a magazine illustration. From this picture a reasonably accurate, a highly detailed and a useful map could easily be made.[14] Captain Stevens, in 1929, made a clear picture of Mount Ranier from a horizontal air-line distance of 227 miles. This picture shows rather clearly the curvature of the earth.[15] Contour maps have been made of considerable areas by aerial photographic methods and equipment, on which the contour lines were placed within one foot of their true vertical position as determined by instrumental measurements. With the latest American type of four-lens camera a plane flying at 10,000 feet above terrain permits the photographing of a strip at least 6 miles wide at a single flight. A new single-lens camera recently designed and put into service pictures an area of approximately 16.5 square miles on a 6X8 plate at an altitude of 16,500 feet above terrain.[16] A recently published account of a European camera claims a range even greater than that. Some splendid research laboratories are at work on the improvement of aerial photographic mapping equipment and methods and progress is so rapid that the isolated worker finds it most difficult to keep abreast of current progress.

It seems inevitable that plant ecologists and plant geographers will make liberal use of aerial photographs for the study of vegetation en masse and for extensive studies of plant distribution. In a forested country such work is, of course, an important phase of forest study.

Personally the writer looks forward with confidence to the day when it will be possible to consult a large-scale vertical photograph of any selected square mile in the United States and on the photograph see far more detail than one could hope to see standing on the ground in the center of the section or by making one or two trips across the section. Dusting with poisons for control of nisect defoliators inparks, possibly also in some forests, seems not so remote a possibility as flying becomes cheaper and planes more numerous nad efficient. It does not appear that this method of control is likely to become generally paplicable over large areas of rugged mountain forests. An even distribution of dust over rough terrain is extremely difficult to attain, the cost per acre of the work is relatively high, and the danger of destroying bird and animal life is an important consideration. A report from the great smelters near Butte, Montana, indicating that there are now some 20,000 tons of a dust havnig a high arsenic content at that place, with only a limited demand for it, suggests that the cost of arsenical poisons may not be a prohibitive one in the future. From Germany comes a report of a new calcium arsenate compound known as "Heryinia," containing 10- 12% arsenious acid and adapted to dusting forests from airplanes. It has proven superior to other dusts in spreading and adhesive qualities. It is said to have been effective against several species of defoliators and not poisonous to warm blooded animals. It is reported that a small

airplane treats about 600 acres per day in favorable weather.[17]

Another use of airplanes in the field of forest entomology is in process of development. An ingenious trap has been devised which makes it possible to capture specimens of flying insects at any given time, place and altitude. This opens great possibilities for study of the numbers, distribution and migrations of insects in the upper air. It is planned to make use of this possibility in a study of the movements of the Mountain Pine Beetle, *Dendroctonus monticola* in the Northern Rocky Mountain region in 1931.

With cheaper flying, better disseminating devices, and more suitable dust fungicides, the use of the plane for treating wide-spread epidemics of certain classes of tree diseases may become a practical possibility. So far as can be foreseen at this time its greatest usefulness in that direction will be in connection with field crops, parks and orchards, rather than with forests.

Summary and Conclusions

Airplanes have been continuously used for several lines of forest work in Canada for twelve seasons.

In the United States the airplane has in the last six years permanently become an item of forest equipment.

The role of the airplane in forestry in this country is not at present a large one, nor one of great current importance.

Work with the airplane in forestry has to date been largely experimental and developmental in character.

Increased use of the airplane in American forestry is dependent largely on the further improvement and increased efficiency and safety of the airplane as a machine.

The greatest need in airplanes for forest work at this time is for one that can fly safely at lower speeds and land and take off safely in much smaller fields than those now ruling.

The most promising fields for development appear to lie in aerial transport of men and supplies for fire control and in aerial photograhic mapping.

The cost of flying is great and appears to be declining slowly. High cost of operation is an important factor in limiting use of the airplane in forestry.

Dirigibles or airships in the present state of development do not give much promise of usefulness in the immediate future.

With vast and little developed areas to administer, American foresters cannot afford to neglect or overlook the possibilities of this rapidly developing means of transportation.

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The Relation Between Intelligence and Success In Student Teaching[1]

By
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THE term "intelligence quotient" is a familier one to all of us. Mental tests have come to occupy a recognized place in school administration from the kindergarten to the university. They form a part of the entrance examinations of many institutions of high learning. Elementary schools organize their children in ability groups based upon scores gained by giving an intelligence test.

Because of these facts, the writer of this paper naturally became interested in applying this intellectual measuring stick to his own particular problem, that of selecting student teachers.

The studies reported in this paper represent an attempt to discover how reliable intelligence test scores are in predicting success in student teaching. The following are some of the questions for which answers were sought: Is there a definite relationship between intelligence, as measured by a test, and ability to succeed in student teaching? Do the students who make the highest scores on an intelligence test make the greatest success in their student teaching? Do those students who make low scores in intelligence tests tend to do poorly in student teaching? Is there a minimum score below which a student would be almost certain to fail in her student teaching?

Upon the answers of these questions will depend, to a large extent, the use of intelligence tests in the matter of selecting student teachers. If these questions could all be answered in the affirmative, then we would have a very useful instrument to be used in selecting only those students who would profit by their student teching.

The first study in this connection was a comparative study of the highest and lowest five per cent groups in intelligence. The first group studied consisted of 693 students who took the Army Alpha Intelligence as part of their entrance examinations at the Lewiston Normal School at Lewiston, Idaho. These 693 students represented the total number taking the test between June, 1922, and February, 1926. The second group consisted of 406 students who took the Terman Mental test between June, 1922, and June, 1924.

The scores on the Army Alpha ranged from 62 to 187, with a median of 132.7, which places the general level of intelligence for this group on a level with similar groups that have been studied. Whitney found a median of 135 for 780 graduates of eight normal schools. Peterson and Kudera reported a median of 122 of the student of nine normal school.

The names of the students composing the highest five per cent and the lowest five percent were secured in each group, and then grades in student teaching were secured from the registrar's office.

The average score on the Army Alpha made by the highest group was 176.4 while for the lowest group, it was 77.

The average grade in student teaching was found to be 3.56 for the highest group and 3.5 for the lowest group.

The Terman group of 406 students were dealt with in a similar manner for the purpose of comparing the ex-

[1]Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 29, 30. 1930, Spokane, Wash.

tremes. The median for the highest five per cent in this group was 199.2 and for the lowest five per cent, the median was 78.3.

The highest five per cent made an average in student teaching 3.36 and the lowest five per cent group it was 3.

It appears, from the study that the students with the highest intelligence, as measured by Army Alpha and Terman Intelligence tests, have little better chance to get a high grade in student teaching than those with low intelligence.

It was now decided to get further evidence on this question by engaging in a further study using different groups of students and by making use of the correlation technique. Accordingly three groups were used as follows. A group of 72 students taken at random from the graduates of the Lewiston State Normal School. The second and third groups were made up 82 students each selected at random from the graduates of the Colorado State Teacher's College.

For the Idaho group the correlation between intelligence as measured by Army Alpha and scores student teaching, was -.028. For the Colorado groups the coefficients to correlation between intelligence, as measured by the Thurstone test and ratings in student teaching, was .353 and .23 respectively.

The results of these studies seem to show that there is little relationship between intelligence as measured by a standard intelligence test and student teaching success. These results seem to be in accord with similar investigations made by both Whitney and Pyle. Using 780 cases, Whitney found a coefficient of correlation of .108 between student teaching and intelligence while Professor Pyle found a coefficient of correlation of .153 using 357 students.

The results of the investigations which have attempted to study the relationship between intelligence and success in student teaching have been rather uniform. The evidence in each case points to the fact that there is little or no correlation between intelligence and success in student teaching.

The question naturally arises, "Why is this the case?" Are we to assume that there is no relationship between intelligence and the ability to teach successfully in a teacher-training institution? Or, it may be that the intelligence tests used do not really measure teaching intelligence. Again, it may be possible that our measures of student-teaching success are too subjective to be reliable. Perhaps those who rate student teachers are not trained sufficiently in recognizing and evaluating the factors which go to make up success or failure in student teaching. Finally, the results obtained may be due to certain defects within the investigation itself. That is, the subjects used in these studies may have chosen in such a way as to include certain factors which have contributed to the low correlation.

It was the consideration of this last statement which prompted this last study. In choosing the sutdents to be used, therefore, a careful selection was made from the enrollment of Colorado State Teachers College with the idea of eliminating as many factors as possible which might influence the relationship between intelligence and student-teaching success. It was decided to take only those students enrolled in the two-year course who had taken their student teaching in grades 4, 5, and 6, thus eliminating the kindergarten, primary, and junior and senior high school groups. An examination of the records in the office of the Director of Training yielded the names of 170 students who had taken student teaching in these grades between September, 1926, and June, 1929. This group happened to be all women, thus eliminating sex differences. Next, those students were selec-

ted who entered college immediately upon graduating from high school. Students who had previous teaching experience were eliminated. Finally, only those students were chosen who were born between th years 1905 and 1909, thus limiting th range of ages to four years. After this sifting process was completed, there remained 100 names. Thus, it will be noted, a number of variables were held constant; sex, teaching experience, any general growth which might have been gained by allowing a period of a year or more to elapse between high school graduation and college entrance. Further, the students were nearly the same age and taught in a grade range of three grades.

The seventy students eliminated by the above process differed widely in age and in amount of previous teaching experience. These were used as a control group.

The following data were secured from the office of the registrar: (1) rating in student teaching, (2) score on the Thurstone intelligence examination, and (3) the average of all grades in college courses.

To determine the relationship between the variables for which measures had been obtained, the correlation technique was used, and the following coefficients of correlation of order zero were discovered.

For the selected group of 100 students, the Pearson product moment coefficients of correlation were:

Student teaching and intelligence .238
Student teaching and average grades .472
Intelligence and average grades .500

For the control group of 70 students, the coefficiens were:

Student teaching and intelligence .222
Student teaching and average grades .519
Intelligence and average grades .507

In order to rule out the effect which grades might have upon the relationship between student teaching and intelligence, coefficients of correlation of the next higher order were calculated with results as follows:

Student teaching and intelligence with grades held constant.....-.204

For the control group of 70 students, the coefficients of correlation of the first order were:

Student teaching and intelligence with grades held constant.....-.022

When we compare the coefficients of correlation discovered for these groups described above, it is evident that the careful selection of cases has no apparent effect upon the results, as the two sets of coefficients are almost eactly the same. Age and eperience evidently do not effect the relationship between intelligence and student teaching success. That is, that student teacher who has had teaching experience prior to her student teaching has no advantage over the student teachers who have had no teaching experience. Likewise, the age of the student teacher does not seem to effect her chances for success in student teaching.

By using the method of partial correlation to hold constant the effect of college grades, the coefficients become negative. Apparently, then, whatever relationship was found between intelligence and student teaching was not really due to intelligence, but rather to the influence of college grades.

The investigation, then, seems to warrant the following conclusions:

1. There is little relationship between intelligence as measured by the tests and student teaching success.

2. Achievement in college academic subjects as measured by teachers' marks is more significant as a means of predicting success in student teaching than is intelligence.

3. It is probably safe to conclude from this evidence that the intelligence tests used are not good measures of

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What Has Modern Psychology To Offer In Child Training?[1]

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AS far back as the recorded history of man there is evidence of thoughtful and serious consideration of child training. There is, of course, not time in a brief paper such as this to review of all this evidence. For the purpose of orientation in dealing with the question I am to discuss I shall, however, attempt to give a thumb nail sketch of educational ideas preceding the present day. Thus we may be able to evaluate more accurately recent contributions. I shall begin arbitrarily with the educational ideas of Comenius (1592-1670), a truly remarkable man whose philosophy of education was so advanced and so sound that even yet we have imperfectly succeeded in putting it into practice.

As to the content of the curriculum, Comenius attempted an encyclopedic organization of human knowledge together with revolutionary methods of teaching. He held that it was futile to attempt to transmit knowledge through mere words or symbols and that the procedure should be from the concrete to the abstract. He insisted that only knowledge should be transmitted that would have practical application in life. These ideas he exemplified in numerous textbooks and writings. We pass next to Rousseau who was actively engaged in developing his social and educational ideas near the middle of the 18th century. According to Rousseau education should be based on the

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teaching intelligence no matter how well they may measure abstract intelligence.

4. In a selected group such as that studied, it appears that, given enough intelligence to graduate successfully from high school, added intelligence as measured by tests used has little effect upon student teaching success.

5. The very careful selection of cases had no apparent effect upon the correlation between intelligence and student teaching success.

Finally, in the matter of selecting student teachers, this study seems to indicate two things: first, that the intelligence tests which are now used are of little value in predicting student teaching success. The high correlation between academic achievement and intelligence as measured by these tests and the correspondingly low correlationtion between student teaching success and intelligence seems to piont to the fact that there may be different kinds of intelligence. What these tests measure is academic or abstract intelligence, and not teaching intelligence. Teaching is a complex social activity. Research needs to be done in this connection in an attempt to devise a type of test which will measure social or teaching intelligence, which will do the job as well as the existing tests do for abstract, or academic, intelligence. Second, it would be valuable to attempt to make rating of student teaching as objective as possible by setting up more definite outcomes or goals for student teaching.

nature of the child. By this he meant that the instinctive judgments, primitive emotions, and natural instincts were more trustworthy as bases for child activity than guidance from the experience of adults. In his own words "Everything is good as it comes from the hand of the author of nature; but everything degenerates in the hands of man." Parenthetically we may note that this view is in direct conflict with the views of modern psychologists who hold that original nature being of evolutionary origin is often better suited to the primitive ages which produced it than to modern life and that it therefore often should be changed to conform to preconceived patterns. Rousseau had a wholesome influence, however, in calling attention to the fact that education is a natural and not an artificial process, that development must come from within and through the workings of natural forces and not the mere acquisition of information, and that the child should be recognized as a positive factor in education and not a lump of clay that can be shaped at will. In these concepts we find startling similarities to the philosophy underlying the "child centered" schools of which we have recently heard and read so much.

Passing rapidly on, we come to the 19th century when we find the Pestalozzian movement in full sway. Pestalozzi saw in education a means to social reform through the physical, mental, and moral development of every child. He insisted that education should be universal. Unlike Rousseau, however, he favored a directed educational program in which, to be sure, he urged the utilization of child interest in presenting appropriate experience and exercises. Pestalozzi agreed with Comenius that the precedure should be from the concrete to the abstract. He made systematic attempts to apply his theories to such subjects as arithmetic, drawnig, spelling, geography. One commonly accepted principle in teaching modern geography utilized by Pestalozzi was the principle that the near and known rather than the remote and unknown should furnish the point of departure.

Herbart during the first half of the 19th century accepted much of the work of his predecessors but attempted to put it on a scientific psychological basis. He stressed the unity of mental life and development, a point of view which has recently been urged in certain quarters as a fundamental basis for curriculum construction. Herbart held the mind to be a blank at birth inherently neither good nor bad but capable of being developed one way or the other according to external influences. As pointed out in the comments on Rousseau's naturalistic doctrine, this point of view is still adhered to by modern psychology. Herbart formu lated and developed two principles of fundamental importance, namely (1) The assimilative powers of the mind or the "apperceptive" process as he called it and, (2) that education is the chief means of shaping the mind and character. It needs no argument to show that these are still the chief props of our educational philosophy. For Herbart, the chief purpose of education is ethical or moral. This was to be attained through emphasis on child interests. It is the business of instruction to incite interests and to secure unification or correlation of studies in such a way as to be wholly apperceived by the child and thus broaden and strengthen his personality.

I shall conclude this part of my paper with a brief outline of the Frobelian movement. This movement pertained primarily to one stage of schooling--the kindergarten, although it has since been applied to all stages of schooling. As we have seen, the Herbartion movement is characterized by its emphasis upon the teaching process. The Frobelian movement, on the other hand is characterized by its emphasis on the

importance of the child, his interests, experiences and activites as the starting point and means of instruction. To Froebel, education, beginning with the spontaneous activity of the child and leading from that to ideas and permanently formed volitional interests, was more largely an emotional and volitional rather than an intellectual training. It is interesting to note that this point of view has received support in the writings of two of the most energetic and stimulating modern educational psychologists. Thus Thorndike writes: "Morality is more susceptible than intellect to environmental influence. Moral traits are more often matters of the direction of capacities and the creation of desires and aversions. Over them then education has greater sway, though school education, because of the peculiar narrowness of the school-room, has done little for any save the semi-intellectual virtues." Similarly, Terman has written: "I shall not be surprised if we are in time cmopelled to modify our educational ideal in several respects. In the first place, I think we shall ultimately come to place more emphasis than we do now upon the ethical and social ends of education, and care more than we now do about making the school a wholesome place to live. In the second place, I think that we shall in the future stress more than we now do the training of the child in attitudes and interests as contrasted with the imparting of subject mastery."

Although Froebel's work was done by the middle of the 19th century, the principles he formulated sound amazingly like those stated by textbook writers and curriculum experts of the year 1930. I shall briefly state them: (1) Materials of the curriculum should be selected from life and should come within child experience. (2) Such materials should relate directly to life. (3) Self-activity is the first law of instruction. (4) The creative tendencies of children should be utilized. (5) Play interests must be utilized in education.

I pass now to a more direct consideration of the offerings of modern psychology. As already indicated, modern psychology is agreed that the child starts life with a mind that is a relative blank and that through appropriate stimulation, mental development and character can be guided and controlled. It is true that psychologists differ with each other on the extent to which the above statement is true. The more extreme behaviorists as represented by Watson hold that the possibilities for guiding and controlling human development are unlimited. Thus Watson states: "The Behaviorist hopes to reach such proficiency in our science (psychology) that we can build any man, starting at birth upon order. He hopes also to be able to take an adult failure (if biologically sound) pull him apart, psychologically speaking, and give him a new set of works." Further, he states, "The Behaviorist is inclined to discard the whole concept of instinct and to believe that almost all of the complicated reactions we see in the baby are built in." Quoting still further: "We now know how and why human emotional behavior grows up, why some are fearful, shy, given to anger, rage, jealousy, etc. . These have been built in. We have experimentally studied the process by which they are built in in infancy. They are pretty well established before the end of the second year of infancy. Nurture and not nature is responsible for what the child becomes."

These extreme conclusions by Watson are not shared, however, by his fellow behaviorists. Indeed, one of them, Miss Mateer, has conducted experiments with children in establishing a conditioned salivary reflex which show conclusively that the number of trials necessary for conditioning depend on learning capacity as measured by intelligence and other psychological

tests. That individual differences in learning capacity exist from the time of birth is admitted by psychologists of all schools with the seemingly sole exception of Watson. As already indicated, however, modern psychology is unanimous that control and guidance of mental and moral growth is possible within the limits of each child's original nature. The process through which change is made is usually referred to as "The Principle of Simultaneous Stimulation." This principle may be utilized either in the formation of new synaptic connections or in the elimination of old connections. This is the principle used by the behaviorists in their experiments on the conditioned reflex—for example, in their experiments on how various fears may be established or eliminated in the young infant. I should perhaps here refer to the work of the behaviorists which seems to have established that new born infants are born with only two fears; the fear of loud noises and the fear of withdrawal of support. How then do the many fears observed a little later develop? It is here that the behaviorists have done some of their best work. These fears, they have shown can be built in and can be eliminated again by application of the principle cited above.

I have already referred to the existence in children of individual differences in learning capacity which must be taken into consideration in the application of the principle of simultaneous stimulation. I presume you are also thinking of the law of readiness and its corollary—the law of effect. This law must, of course, also be considered in the actual application of the principle of simultaneous stimulation. I have been informed that Thorndike who first stated this law, has produced experimental evidence that will force us to give much more attention to the law of readiness in our teaching. Briefly, Thorndike's evidence seems to show that with skillful application of the law of readiness, repetition and drill can be greatly minimized. Dr. Guy M. Wilson has made an experimental trial of the matter in the teaching of arithmetic in the primary grades. As you know it is in these grades that we are concerned with a mastery of the "fundamentals" in addition, subtraction, multiplication and division. Dr. Wilson conducted his experiments with two groups of children one of which was taught by the usual drill method and the other by an "informal" method utiliznig plays, games, and otherwise motivating to the end that the law of readiness was utilized. The precedure was entirely informal with no attempts at systematic drill. At the end of the school year, the experimental group showed superior results.

These results are, of course, in line with the principles of the great educational reforms with which I began my paper. Child interest, self activity, plays and games for motivation run as a continuous thread through their contribution to educational theory and practice. You are perhaps now ready to say that there is nothing new under the sun. In a sense, this is perhaps true. There is a new element, however, of more exact scientific experimentation and verification and this to my mind is the chief contribution of modern psychology. Modern educational psychology proceeds to test as rigorously as possible the intuitive and empirical contributions made by educational reformers. It puts to actual trial under scientific conditions the various theories proposed. It makes haste slowly and while it seems less spectacular it makes progress more sure and certain. Modern psychology does not concern itself about the determination of aims and purposes but about the determination of the best methods for realizing the aims and purposes agreed upon by social and philosophical considerations. On the other hand, it does not hesitate

to point out fallacies in such aims and purposes when they come to light. I may refer in this connection to its revelation of the error in Rousseau's assumption of the adequacy of original nature as a safe guide for child activity and training. The same fact is illustrated in the careful and minute scientific examination made by modern psychology of the doctrine of formal discipline as a basis for curriculum construction. Indeed this examination covering a decade of painstaking experimentation constitutes one of its brightest chapters. Curriculum makers must now not only give due regard to social and philosophical considerations but they must also apply the touchstone of psychological experimentation to the determination of the validity of their offerings. It is well to keep this last point in mind for it is unfortunately too easy to allow oneself to be carried away on a wave of enthusiasm for some new curricular scheme. Let me give one concrete illustration of this danger. Recently I have read and heard certain proponents of curriculum construction. Some members of this group would base the curriculum on the actual interests and activities of children thus making Rousseau's assumption of the infallibility of child nature as a proper criterion. One procedure would obtain by questionnaire to the children concerned a cross-section of interests and activities as a basis for the curriculum. This overlooks the fact that different children have different interests and activities. Any given child would therefore be faced with interests and activities that are not his own and so will not be any better off than if the curriculum were imposed upon him by adults as it now is. Finally, the assertion is made that the training secured which is based on such a curriculum is the best possible preparation for adult life. Here the assumption is made that there will be a transfer of powers acquired in training to activities of adult life. Psychology tells us that such transfer can only be expected to the extent that identical elements are present in the two situations. If I may venture an opinion on this matter in closing, it is this: Difficult though it may be, we adults cannot shirk our responsibility in making our experience available to the next generation to the end that trial and error will be minimized. Psychology tells us that the new born child is relatively free from predispositions and is plastic and thus highly susceptible to training in any desired direction. Psychology also gives us many clues that we can utilize in making a child's progress towards the desired goal happy and pleasant. Purposive education rather than education of the Topsy variety is our responsibility and duty.

Bronchoscopy and Esophagoscopy[1]

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WE of the medical profession recognize the worth and hold in high esteem the work of your organization. Your gatherings give great impetus to the advancement of science which is necessary for the progress of human life. No field of science has been left untouched in your deliberations. Consequently the medical art is very much in the debt of such organizations as yours since the results of scientific research have been so helpful in furthering the work of healing and the prevention of disease. In recent years the scope of medicine has assumed such great proportions that specialization has become an urgent necessity. It is my intention to present this afternoon for your consideration the advances of one of these specialties, namely, Bronchoscopy and Esophagoscopy.

Bronchoscopy and Esophagoscopy comprise the art and the science of direct internal examination and treatment of the air and food passages in the human form when they have become disordered. In point of years this specialty is very old. Foreign bodies have been removed from the air passages by various methods for several decades. As Professor McCrae well says,—"The time has passed when the lodgment of a foreign body in the air and food passages is considered as a curiosity of medicine." The wider scope, however, and more recent development in this field have placed Bronchoscopy in the lime-light of modern medicine and surgery.

The removal of foreign bodies from the air and food passages was a prolonged and cumbersome process. Often times open surgery had to be resorted to. General anesthetics were found to be dangerous obviously from the presence of the foreign body in the windpipe. Bronchoscopes were not well lighted. Air valves were lacking. Suction, which is of great value, was not used. Forceps were not to be had to handle the dangerous safety-pin. In fact, the armamentarium of the physician consisted of nothing more than the heavy old style bronchoscope and heavy grasping forceps. Failures were many and consequently mortality was high. With the advent of modern development there comes the distally lighted bronchoscope with suction and air valves, shaped to fit every type of emergency. Forceps are designed by master craftsmen for every conceivable foreign body that a child might choke upon. Forceps are designed to handle the problem of the tack, straight pin and safety-pin; rotation forceps and instruments for the removal of growths. There are suction tubes and tubes for the instillation of antiseptics directly into the lung cavities; pressure bags for dilatation of esophageal strictures; also, bougies both direct and retrogade for the treatment of esophageal strictures and many others.

More important than the armamen-

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tarium of instruments, however, are the dogmatic facts emanating from the various clinics of endoscopy that have contributed most toward this specialty. They reveal a wonderfully well developed science planned with the greatest attention to the most minute detail, and a close study of the failures of early bronchoscopy with well thought out remedies. For example, whether or not there is a clasp over the spring of a safety-pin which, if present in a bronchus, presents a more difficult problem in its removal; principles such as "advancing points perforate, trailing points do not" in the removal of a sharp pointed foreign body; practice on the manikin, the cadaver and the dog for the beginner, etc.

So completely is this technique developed that any man of ordinary skill, provided he takes the time and energy to study the principals and continually practice them, should be able to do good endoscopy. Education of the eye and the fingers is paramount. It is just as difficult to do good bronschopy without practice as it would be to take up a violin for the first time and play a selection from one of the old masters.

The practical application of this science covers a large field. Besides the removal of foreign bodies the direct treatment of lung abscess is greatly enhanced. Direct aspiration of the abscess cavity by bronchoscopy and direct instillation of antiseptic substances into the cavity is carried out at weekly intervals. The direct treatment of bronchiectasis is carried out. Radio opague materials such as lipiodal and bismuth subcarbonate are instilled to aid X-ray diagnosis. Bronchial asthma is treated occasionally but not tuberculosis. The problem of non-opague foreign bodies such as peanut kernals has been thoroughly studied. The phenomena resulting from obstruction of the air passages have been placed before the profession. Thorough knowledge of the mechanism of such obstruction to the inlet of air into various lung areas with their signs and symptoms have made the diagnosis of non-opague foreign bodies in the lung most accurate.

In carrying out this sort of treatment general anesthesia is not used. A preliminary hypodermic of morphine supported by atropine is given and the local application of cocaine is made to the throat. The patient is held in proper position on the operating table. The actual passing of the bronchscope or esophagoscope is not necessarily painful.When it is in place in the lung the patient breathes through the tube. After the first moment of apprehension on the part of the patient is passed little difficulty is encountered. A foreign body lodged in the windpipe is apt to cause total obstruction and asphyxiation if general anesthesia is used. Without it the patient may be of aid by coughing or holding the breath if such may be necessary. It should not take more than one minute to insert the tube in proper position. Many foreign bodies are removed in a few minutes. Others, depending on size, shape and location, require longer periods of time. All considered it is a vastly more important method of procedure to the welfare of the patient than the older and dangerous open operation of a few decades ago.

Some Casual Observations on Hatching of Chinese Pheasant Eggs Under Adverse Conditions[1]

By

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FROM time to time I have found the nests of Chinese pheasants in field, orchard, and open woodland of the Spokane valley, where this bird has become so abundant in the game preserve area.

Apparently these birds have adapted themselves very well to this thickly populated and intensively cultivated area as regards food habits and general living conditions, but so much cannot be said of their nesting habits. In the last particular they seem to be governed wholly by instinct which is not so reliable in cultivated areas. Frequent reports of destruction of nests, or killing or injuring of birds by cultivation or harvesting processes attest this fact.

I have observed several nests so located as to suffer frequent disturbance by workmen or irrigation waters. As a rule they are very well screened from the eye, and the remarkable protective coloration of both bird and eggs assure comparative safety from that point of view. The nest is rudely formed, on the ground, a place being hollowed out and a small quantity of grass or straw being used for lining.

I became particularly interested in a nest located in an irrigated oats field. A more undesirable spot could scarcely have been chosen. Within a few feet in any direction a safer location could have been found. During irrigation the area was flooded to a depth of from one to three inches. The temperature of the water used for irrigation in Spokane Valley varies from 45 degrees to 50 degrees F., and rises but little when poured from the weir. In spite of this cold flood of water the hen doggedly sat on her nest until stepped upon by the irritator. When frightened away, however, she did not return until daylight—seven hours later. In the meantime the eggs were completely submerged for a period of four hours, and lay in the damp nest during the chill of the night for three hours longer. This experience was repeated in every detail eight days later, except that at that time an egg was broken by the foot of the workman. A few days later the crop was removed, being cut with a binder, which fortunately did not destroy the nest, but of course the protective screening was removed.

During all these experiences the hen faithfully returned to her nest, and was rewarded in the end by a 100% hatch except for the broken egg.

The remarkable resistance to chill exhibited in this case may account in part for the indifference of these birds to their choice of a suitable location of nests, but instinctive control seems more probable, and instincts take no account of irrigation and cultivation.

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A Qualitative Separation of Cadmium From Copper[1]

By

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A qualitative separation of cadmium from copper may be effected by the use of amonium carbonate in neutral or slightly alkaline solutions. The action of the ammonium carbonate on solutions of cadmium ions may be formulated as follows: $2\ CD^{++} + (NH_4)_2\ CO_3 + 2H_2O = Cd_2(OH)_2CO_3 + 2\ NH_4^+ + 2\ H^+$ The formation of the insoluble basic cadmium carbonate constitutes a difference between the reactions of cadmium and copper ions as the copper carbonate which is formed in the reaction is soluble in excess of the reagent, or in ammonium salts, to form the soluble $Cu(NH_3)_4^{++}$ ions. The white, dense (and usually quite small) precipitate of basic cadmium carbonate is insoluble in excess of the reagent. Ammonium salts may tend to inhibit the precipitation of the basic cadmium carbonate. However, on boiling the solution, ammonia is evolved and the precipitation is complete.

The mechanical directions for the separation are: Filtrate containing Cu^{++}, Cd^{++}, and a slight excess NH_4OH. If copper is present (indicated by the deep blue coloration of the $Cu(NH_3)_4^{++}$ ion) add 10cc. of $(NH_4)_2CO_3$ reagent and boil for several minutes. Allow the solution to cool to room temperature. Filter off the small, white precipitate of $Cd_2(OH)_2CO_3$ and wash with water until no trace of the blue color due to the $Cu(NH_3)_4^{++}$ ions can be seen on the filter paper. Discard the washings. Dissolve the precipitate off the filter using the smallest necessary amount of dilute HCI.

Neutralize this solution containing Cd^{++} ions with dilute NH_4OH. Render just acid with dilute $HC_2H_3O_2$. Saturate with H_2S. A yellow coloration (in case of small quantities of Cd in sample) or a yellow flocculent precipitate indicates the presence of Cadmium.

This separation is not as complete as the often used separation based upon the precipitation of CdS in KCN solution. However there are certain advantages which suggest its use:

1. The use of KCN is avoided. This is especially desirable in elementary classes.

2. The reactions are readily understood by the students and illustrate a difference between the chemistry of cadmium and copper.

3. The confirmatory precipitation of CdS is clean, and CuS is precipitated from acid solutions of Cu^{++} and Cd^{++} ions.

This method of separation of cadmium from copper has been tried and found satisfactory for general qualita-

[1]Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 29, 30, 1930, Spokane, Wn.

tive class use in the chemical laboratories of the State College of Washing ton during the past semester.*

+The author wishes to acknowledge the kind cooperation of Dr. R. W. Gelbach, of the State College of Washington, in making the laboratory trial possible.

However, certain precautions must be observed:

1. The concentration of the Cd^{++} ions in the original sample must be such that the concentration of Cd^{++}ions in the solution at the time of the separation is at least one milligram of Cd^{++} ions per cc. A concentration of two milligrams, or more, per cc. makes the confirmatory test more satisfactory.

2. Care must be exercised to insure complete precipitation of the CdS at the time of the original Group II precipitation. (This is a necessary precaution no matter what Cd - Cu separation is used.)

3. Care must be exercised to insure transfer of all of the precipitate of basic cadmium carbonate to the filter. This precipitate is usually quite dense and small and may be partially lost in the transfer.

While it is evident that the separation is not without disadvantages, the fact that it afords an escape from the use of KCN, and at the same time produces a bright yellow confirmatory precipitate of CdS, should commend its use.

*The author wishes to acknowledge the kind cooperation of Dr. R. W. Gelbach, of the State College of Washington, in making the laboratory trial possible.

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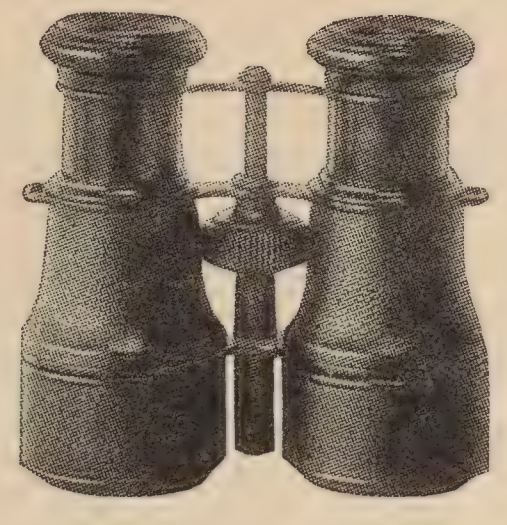

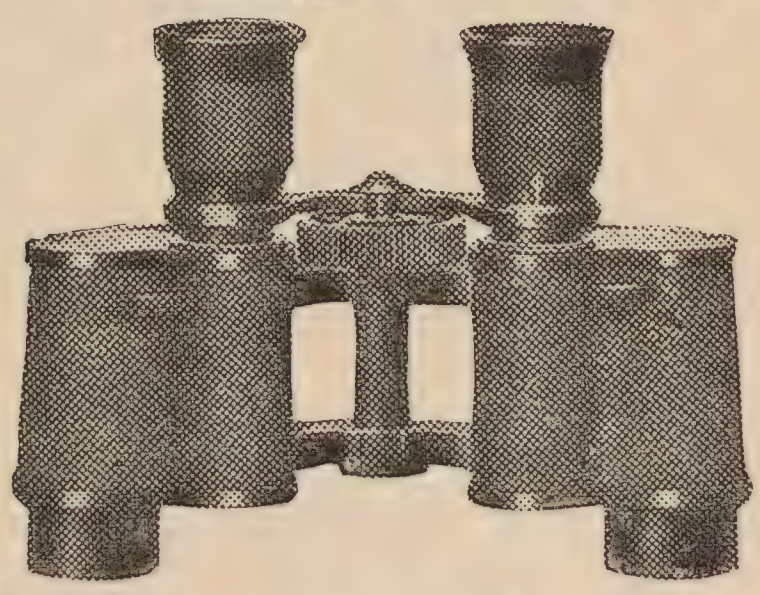

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Spread and Development of White Pine Blister Rus In the Inland Empire[1]

By H. N. PUTNAM

Office of Blister Rust Control, Spokane, Wash.

Introduction

The best stand of western white pine in the world occupies over three million acres in the Inland Empire. In north Idaho alone there are over two and a half million acres of white pine type. White pine blister rust is firmly established in these forests and threatens their very existence unless energetic and timely action is taken to protect them by the eradication of Ribes (currant and gooseberry bushes).

Life History of Blister Rust

In order to properly understand the blister rust situation in north Idaho it is nesessary to stress certain points in the life history of the pest. It is, of course, well understood that blister rust is a fungous disease very destructive to white or five-needled pines. It requires the presence of Ribes leaves to complete its life cycle. The rust infects the pines through the needles. The Ribes infecting spores (aeciospores), from cankers on the pines, are capable of living a long time in the air, and this characteristic results in causing Ribes infection often at long distances from infected pines. Examples have been found where Ribes have become infected very probably a hundred miles or more from infected pines.

On the other hand, the pine infecting spores (sporidia) produced from telia on the Ribes leaves are very thin-walled and die shortly after they are produced. Thus the inability of the sporidia to survive for any considerable length of time results in a relatively short distance spread of infection from Ribes to pines. In the west it is possible that a greater zone than the 900 feet used under eastern conditions will be required. However, it is now considered sufficient protection to the pines in Idaho if the upland type Ribes are eradicated for a distance not to exceed 1500 feet and the stream bottom Ribes for a distance of one half or sometimes a mile from the pines being protected. This greater distance from stream bottom Ribes is necessary because Ribes species of the highest relative susceptibility occur in stream bottoms in the greatest concentrations under moisture conditions most favorable to the rust.

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[1]Presented at the Annual Meeting of the Northwest Scientific Association, Dec. 29, 30, 1930, Spokane, Wash.

Wave of Infection

Blister rust infection on pine develops slowly during its early stages. The first symptom of the disease in the pine bark usually becomes visible as a yellowish discoloration about the base of the needle fascicle containing the needle through which the infection entered, during the second or third season after the infection enters the needle. Another season normally elapses before the resultant canker is sufficiently developed to produce its first aeciospores. After this the canker, if normal, makes annual progress in the bark and produces aeciospores each season until interrupted by the death of the tree or the infected part. The pine infections which result from an initial infection on Ribes in a locality play no part in the spread of the rust until aeciospores are produced on the resultant cankers. Then the rust is spread back to Ribes and a new wave of pine infection may occur. Following the establishment of the rust in a locality (usually by long distance spread of aeciospores from pine to Ribes) its increase on both Ribes and pines bears a direct relationship to the volume of aeciospores produced. Seasons and sites vary widely with respect to conditions favorable for the spread of the rust on Ribes and back to pines. Cool, moist summers with relatively low temperatures represent maximum conditions for natural spread of the rust, whereas, dry, hot summers are unfavorable. In general the rust spreads by waves, the high points in which denote seasons of the most favorable weather conditions. A Ribes bush became infected, for example, in 1923, possibly from infected pine some distance away. The rust intensified itself on nearby Ribes leaves during the same summer, and in late summer produced a limited amount of pine infecting spores. These in turn caused a few pine infections through the needles of nearby pines.

The cankers formed from the infections that took place in 1923 developed and in 1926, three years after infection, most of them produced aeciospores for the first time. The year 1926 was dry and not a good year for the rust to spread. By 1927 the same cankers aided by others of the same age retarded a year in development produced a still larger volume of aeciospores. Coupled with a good spread year, that is, sufficient moisture and other favorable conditions during the summer as occurred in 1927, there resulted a tremendously greater infection of Ribes and production of sporidia (pine infecting spores) in 1927 than in 1923, with a consequent great increase in numbers of cankers formed on the pines over a large area. These cankers, in turn, continued the spreading and intensification of the disease still farther, not only in the immediate vicinity of the infection under consideration, but also in the formation of new infection centers at varying distances away.

As time goes on, owing to the large numbers of fruiting cankers at each infection center there will result waves of infection yearly instead of every three or four years if weather conditions are right.

The present status of infection in the West exemplifies very well the rapidity and thoroughness with which the rust has spread. In 1910 the rust was introduced into the West at Vancouver, B. C., coming in on a few infected pines shipped from a nursery in France. By a series of waves of infection ever increasing in size and area, it has extended its known range southward to within practically 40 miles of the California line, and east and southeast to include southeastern British Columbia and practically the entire commercial white pine region of the Inland Empire. Thus, in twenty years it has developed from a few cankers in one locality to untold mil-

lions of cankers in untold thousands of infection centers. At each new infection center the same process of multiplication has taken place. What the next twenty years will bring forth, if the Ribes are left undisturbed, using as the beginning of the geometrical series many millions of cankers instead of a few, is difficult for the imagination to grasp. There will be a certain diminution due to the death of infected trees, but so long as green pine foliage remains, there will be an increase in infection.

Status of Blister Rust in Inland Empire

Coming now to what has happened in the Inland Empire, the region in which we are most interested at the present time, we find there are several well established pine infection centers known. Analyses of cankers found indicate that the year 1923 was the year of introduction of the rust in the Inland Empire at points extending from Newman Lake, Washington near Spokane, southward to the southern limit of commercial western white pine near Pierce, Idaho.

In detail these points at which apparently the rust first attacked the Ribes in 1923 and pines became infected therefrom, are as follows: Newman Lake, 25 miles northeast of Spokane, Washington; St. Maries River, near Clarkia, Idaho; Long Meadow Creek, and Elk Creek, both near Elk River, Idaho; and Rhodes Creek, near Pierce, Idaho. These constitute our known infection centers of 1923 origin. There can be no doubt that many others exist not yet discovered. It is also very possible that infection centers dating prior to 1923 exist.

There are also several other pine infection points where canker analyses indicate that pine infection originated from Ribes infected in 1927. These are; two points on Johnson Creek, one each on Shattuck and Cameron Creeks, all near Elk River, Idaho; two points on the North Fork of Reed's Creek, and one on Beaver Creek, all near Headquarters, Idaho; one each on Orofino Creek, near Pierce, Idaho, and on Hammond Creek, near Avery, Idaho. Very probably many of these 1927 pine infection centers resulted from aeciospores formed in older infection centers in the general region i.e. 1923. Thus the same ability of the disease to extend its limits from Vancouver, B. C., to the Inland Empire by waves is recognized in its ability to spread and intensify itself locally.

In addition to the pine infections already enumerated other points widely distributed over the white pine region of the Inland Empire have been found where Ribes only were seen infected. In 1927, when blister rust was first found in Idaho, a single Ribes infection was found six miles north of Priest River on the Kaniskɯ National Forest.

In 1928 a small amount of Ribes infection was found on the west branch of Priest River in the same forest. A solitary Ribes infection was found that same year on Rattle Creek in the Pend Oreille National Forest. Another Ribes infection was found near Burke, Idaho. Numerous Ribes infections were found at various points on the Coeur d'Alene and Potlatch Timber Protective Association lands near Clarkia, Collins, Bovill and Elk River, and in the Clearwater Region near Headquarters, Pierce and Oxford Ranger Station. Ribes infection was found for the first time in Montana near Noxon.

In 1929 the bulk of scouting was performed in the southern half of the Idaho white pine type and in Montana. Ribes infection was found widespread over the Potlatch and Clearwater regions. Infected Ribes were found about nine miles air line west of the Savenac Nursery at Haugen, Mon-

tana. It was during 1929 that pine infection was found for the first time in Idaho, in the Potlatch and Clearwater regions, and on the St. Maries River.

The year 1930 is marked by the finding of numerous new pine infection centers in the southern portion of the white pine belt, and by the discovery of very large increases in numbers of cankers at older infection centers. No infection was found in the northern part of the white pine belt. Ribes infection was found at three places near Haugan, Montana, within one and one-half to four miles from Savenac Nursery. As is well known, Savenac Nursery is the Forest Service source of forest tree planting stock for Region One. It is the largest producer of western white pine planting stock in the United States. Several million western white pine seedlings and transplants are grown here. It is of the utmost importance that this planting stock be kept free from blister rust by the establishment and maintenance of a Ribes free zone one mile in width around the nursery. Intensive methods of Ribes eradication in an area of heavy Ribes concentrations during the past three years have been successful in establishing control here. This condition must be maintained.

The value of finding Ribes infection should be emphasized here. Each Ribes infection represents a potential pine infection. Heavy and well distributed Ribes infection is a good indication that pine infection already exists in the locality. It was by means of Ribes infection leads that many of pine infection centers have been found three or more years after the first long-distance spread of rust to the Ribes of these centers.

The situation at the present time is as follows: Blister rust is known to exist on pines on or near the Coeur d'Alene, St. Joe and Clearwater National Forests. Ribes infection has been found on every one of the five white pine National Forests of Idaho, and on the Kootenai and Lolo National Forests of Montana.

During 1930 disease surveys were run on the three largest known infection centers in Idaho, namely, Long Meadow, Elk and Deep Creeks, and St. Maries River. Strips were run through the infected areas every five or ten chains, making a 2% or 4% cruise of each area. The results of these studies give us the present known status of each infection center.

A 4% cruise was made of the Long Meadow area. It is essentially an upland type of infection, caused by the presence of *Ribes viscossimum* and *Ribes lacustre* at the rate of 50 to 100 bushes per acre. The stand consists of pole growth 20 to 40 years old averaging 754 white pines per acre. The infecting Ribes were scattered over the tract in close association with the pines. Infection apparently started in 1923 from a clump of currants and intensified so rapidly that by 1928 it had infected from 75 per cent to 100 per cent of the trees on 2.7 acres, and averaged 18 per cent infected pines over an area of approximately 48 acres.

It might be well at this point to stress the fact that there are not less than 120.000 blister rust cankers present on the trees in this area. A few cankers originating in 1923 have multiplied at least a thousand times in the succeeding 7 years. The 1923 cankers sporulated first in 1926, and cankers formed in 1926 produced aecia for the first time in 1929. Since it requires 2 to 3 years after needle infection takes place before the resultant cankers become apparent, the cankers now showing in the area are mostly the result of infection in 1926, 1927, and 1928. Part of the 1928 cankers and all of the

1929 and 1930 cankers are yet to appear. What the development from the cankers now present will be in the next 7 years, at a similar rate of increase, staggers the imagination.

The Long Meadow infection area is the most severe known in Idaho. The other two known major infection areas on Elk Creek and Deep Creek and on St. Maries River, are both stream bottom infection centers, probably originating in 1923. The Elk and Deep Creek infection has developed from a few cankers on a small area in 1923 to approximately 14,000 cankers on 56 acres in 1930 with 26% of the pines infected. The St. Maries River infection has developed since 1923 to approximately 9,000 cankers on 264 acres, with 12½ per cent of the pines infected.

What May be Expected if Blister Rust is Not Controlled

Within the next decade, unless control is firmly established, we may expect a wholesale spread of blister rust over the entire western white pine area. The establishment of new and secondary infection centers, the formation of which has already been explained, may be expected at a high rate of increase which would result in ever-increasing numbers of infection centers. As time goes on these infection centers would become so numerous as to coalesce and form practically continuous infection throughout the region. In the generally infected zone, there would be islands, or oases, of non-infection due to a variety of natural causes.

During the next ten years we may also expect the killing effect of blister rust to be apparent. The great majority of the pines now infected will be dead or dying.

There are two general types of killing caused by blister rust: (1) girdling of the trunk by a single rust canker, either by the rust entering a needle on the trunk directly, or else by growth of the fungus from an infected limb into the trunk; and (2) killing by multiple cankers whereby each twig becomes infected and the consequent death of the tree is coincident with the death of the twigs.

The first method, that of girdling, is the type of killing usual in the East where there are fewer Ribes and the eastern white pine is more resistant to the rust, hence fewer cankers per tree result. In the West, owing to the great profusion of wild Ribes, and the high susceptibility of the western white pine it is probable that the second type of killing, that caused by early death of all twigs, will be important. Considerable evidence of this is already at hand.

As to how long after infection of pines, it will require to kill trees of the various size classes, we have not as yet a great deal of information here in the West. It may require from five to fifteen years to kill trees by twig killing, depending upon the number and size of twigs, and the severity of infection. H. G. Lachmund, of the Office of Forest Pathology, has concluded from studies made in British Columbia, that it requires from fifteen to thirty years to render trees of mature size unmerchantable by girdling by the rust. In many cases there is time to harvest a mature stand after infection occurs. With young stands, however, it is certain that trees of reproduction and sapling sizes will die before reaching maturity, or commercial value. It must be borne in mind that so long as Ribes remain near the pines there will be steady intensification of the rust cankers which must cut down the time required to kill.

What the Control Program Must Accomplish

Blister rust can be controlled. It has been done in the East and eastern

(Continued on page 58)

Some Matters of Finance[1]

By
ORVILLE C. PRATT
Supt. Spokane Public Schools

WHILE on his summer vacation trip a minister consented to preach in a near by Episcopal church. When he entered the church the sexton asked him if he wished to wear a surplice. "Why, man," he exclaimed, "I'm a Methodist. What do I know about surplices? All I know about is deficits."

Under present conditions the schools find themselves in the same position of knowing more about a deficit than a surplus. We are much like the pedestrian who, bumped by a taxi, found himself lying in the street directly in the path of a steam roller. "That reminds me," he cried, "I was to bring home some pancake flour." At the recent session of the legislature it looked for a time as if the schools of Washington were to be flattened out by the Juggernaut of House Bill, No. 17.

Now, having escaped temporarily from a position calculated to remind one of pancake flour, we are situated like the negro congregation to whom the preacher said: "Bredren, we mus' remedy de status quo." "What am de status quo?" asked one of the brethren. "Dat, brudder," answered the preacher, "am Latin for de fix we is in." The schools of Washington and of the nation are faced by a crisis such as has not been met before for a generation. It behooves us to study, think and do whatever we can to remedy conditions.

We are familiar with the assertion that ours is a machine age, but we are apt not to realize fully the implications of that fact. We speak of the Industrial Revolution as if it were over whereas its transforming effects on life are still in full tidal flow. In 1849, eighty years after James Watt took out his patent on his "fire machine", the first effective steam engine, there was in use in the United States power amounting to one-half horse power per person. Now, eighty years later, the horse power is ten per person. This horse power is said to be the equivalent of one hundred mechanical slaves for each man, woman and child in the nation. In 1849 the products of factories aggregated a billion dollars in

1. Presented at the annual meeting of the Northwest Scientific Association, December 29, 30, 1930, Spokane, Washington.

Spread and Development of White Pine Blister Rust In the Inland Empire

(Continued from page 57)

pines are being grown profitably in infected regions. In order to avoid severe losses in the West we must at once institute thorough and systematic control practices on a large scale. Time is the all-important item. The disease is intensifying itself rapidly, and we must keep ahead of it, at least so far as is humanly possible. We must think of local control practices as just as essential a part of the forest protection program in white pine forests as is fire protection. Without blister rust control we will have a desert of dead and dying white pines with occasional oases of surviving pines. With control we will have white pine forests with occasional spots of dead trees where control was either not established, or established too late. Which will it be?

value; in 1929 their value was $68,000,000,000.

Throughout this period of stupendous mechanical development, work has been constantly shifted from the muscles of men to machines energized by steam or electricity. For instance, in Milwaukee is located an auto frame plant which employs 200 men and turns out 8,000 auto frames a day. Because of a greater use of machinery the output per man is 240 times as much as in Germany. In the modern shoe factory a machine makes as many shoes as formerly required 250 men. In the making of razor blades a new machine turns out as many as were formerly produced by 500 workers. Another new machine makes as many electric light bulbs as a thousand men could make without it. One girl, by the use of modern spinning machinery, can do as much spinning as 45,000 spinsters could do by hand 150 years ago.

The result has been a constantly increasing output per worker and a constantly decreasing number of workers. For instance, since 1921, the annual output per worker has increased seven per cent a year and the number of workers has decreased one and one-half per cent a year. Agriculture may be taken as a good illustration of this trend. The problem has shifted from how to get enough to what to do with too much. The farm population constituted 83 per cent of all in 1820, but only 26 per cent in 1920, while 15 per cent with modern machinery could produce all we could use. A century ago, with sickle and flail, it took 40 hours to harvest an acre of wheat; now, with tractor and combine, it takes only 40 minutes.

Over-production has been a very natural consequence, not only in agriculture, but also in practically every line of industry. Twice as many automobiles and five times as many radios could be produced by existing factories as could possibly be sold. Over-production directed attention toward increasing consumption. First, high pressure salesmanship appeared to put the budge into every family budget. Then advertising grew enormously until about three-fourths of the financial support of newspapers comes from that source. Then, beginning on a large scale in 1921, installment selling came into the picture with four billion dollars of time sales, or an indebtedness of $250 a family, when the present depression arrived in 1929. Eighty-five per cent of all automobiles are sold on deferred payments. Installment selling adds approximately 25 per cent to the selling price and tends thereby to reduce consumption. But its widespread use reminds one of the man who was referred to as a human dynamo. "How's that?" inquired someone. "Why not," was the reply, "everything he has on is charged."

When over-production reaches a certain point factories curtail output, discharge some employees, or shut down altogether. Then come unemployment and depression in the business cycle. In 1919 the value added by manufacturing was $25,000,000,000; in 1929 it was $31,000,000,000. Of this increase of six billion dollars, one billion only went to the workers and five billions went to the owners, who used it chiefly in enlarging the manufacturing plants and turning out a still larger stream of products. Production was greatly increased but consumption was not made possible in equal measure. In this fact lies the chief cause of the present depression. The president of the Philadelphia Chamber of Commerce is authority for saying that a dollar a week per worker makes the difference between prosperity and adversity. If the six billion increase in the value of manufactured

goods had been divided in such a way that the balance between production and consumption had been maintained there would have been no depression.

Viewed over the perspective of a century, standards of living have advanced almost beyond belief. A hundred years ago there were 16 necessities; now there are 94. Then there were 92 individual wants; now there are 484. Then there were 200 separate articles ministering to human wants; now there are 32,000. And along with rising standards of living the population of the world more than doubled in the century.

Even a quarter-century shows a startling advance. Twenty-five years ago there was one pair of silk stockings for every 2,000 women in the United States; now there are two pairs for each woman. Then there were only a few hundred miles of surfaced highways; now there are 40,000 miles of such highways. Then there was one telephone for every 66 people; now one for every six people. Then there were very few automobiles; now we own 78 per cent of all the automobiles in the world and could take our entire population riding at one time.

All of this has been accomplished with less and less time-expenditure by workers. Twenty years ago only eight per cent of the laborers worked 48 hours a week or less; now fifty per cent work 48 hours as a maximum. There are at least a million workers already on a five-day week. There were 52 million playing cards turned out last year. Think what an enormous amount of spare time that means! We have more young people in college than all the rest of the world put together.

Along with this general advance in standards of living has come increased generosity to the schools. The present depression has brought a temporary check or possibly a recession in this trend. For instance, in Washington last school year salaries decreased 1½ per cent. However, in this connection, it should be remembered that the cost of living dropped six per cent in the same time. Hence, the net result was an increase of 4½ per cent in the buying power of teachers.

Apparently, we are now in the midst of the third great post-war depression through which the United States has passed. Following the War of 1812 prices dropped to half of their former height between 1814 and 1824. The same thing happened after the Civil War between 1866 and 1876. Retail prices are still fifty per cent higher than before the Great War, but wholesale prices have dropped 24 per cent since the depression began. Retail prices have fallen half of that distance and will eventually overtake the wholesale recession in prices.

If salary schedules could be maintained while prices decline, the effect would be the same as an increase in salaries. However, in many states this year the governors advised the legislatures to decrease the amount of money available for education. Undoubtedly, education will be on the defensive while the depression lasts.

Unfortunately, there is another threatening factor in the situation. This is the disintegration of the general property tax. The weakness of this tax is that it does not conform to the basic tenet of taxation, ability to pay. It is based on legal ownership or possession of property, not on economic or actual ownership. If you buy a $4,000 home and pay $2,000 down, borrowing the other $2,000, you at once pay all the taxes and the person who loaned you the $2,000 pays no taxes at all, although his ownership is equal to yours. The trend for many years has been for property to take the

intangible form of stocks, bonds, mortgages, etc., and thereby escape taxation. The result has been that farms and homes are carrying a heavy overload of taxes and intangibles no taxes at all. It is estimated that real estate constitutes 35 per cent of the property valuation of the state, but pays more than 80 per cent of the taxes. Farms and homes have fallen in value and many have been taken over for nonpayment of taxes.

What is imperatively needed is a shift in taxation so that real estate can be relieved of its excess load of taxation. Such a shift is going on quite generally in the United States and must eventually be made in every state. For instance, education is supported in part by severance taxes in seven states; by personal income taxes in seven states; by tobacco taxes in five states; and by corporation taxes in thirteen states.

We need to know and need to cause others to know that while the schools cost more than formerly, the proportion of taxes going to the schools has not increased. In 1913 the schools received 23.79 per cent of all tax money; in 1926, 23.69 per cent. In the United States about one dime of each income dollar goes for taxes; in Japan, 14c; in France and Austria, 17c; in Hungary and Italy, 18c; in Germany and Norway, 20c; and in Great Britain, 22c. Moreover, taxes are paid in the United States out of an income per capita of $752; in Great Britain, $427; in Germany, $197; in France, $187; in Italy, $109; and in Japan, $69. Again, the wealth per capita in the United States is $2,977 as compared with $2,806 in Great Britain; $1,560 in France; $1,067 in Germany; $891 in Japan; and $641 in Italy.

The wealth of the United States increased by 88 per cent between 1914 and 1929; and from 320 billions of dollars in 1922 to 361 billions in 1929. Let us not forget that the chief reason for the wonderful progress of the United States is its universal education. In the face of such facts as those here cited education cannot fairly be said to cost more than the people can afford. Moreover, the Pacific Northwest is one of the richest sections of the nation. While the per capita wealth of the United States is $2,977, Washington stands ninth in the nation with a per capita of $3,669; Oregon stands seventh with $4,084; Idaho sixth with $4,119; and Montana third with $4,755.

In the light of such facts the claim that people cannot stand present expenditures for education reminds one of the young married man who told his wife not to worry; that he would manage to get the piano upstairs by himself. Some years later she asked him to bring home a spool of thread. "Bring a spool of thread?" he exclaimed. "Do you think I am a packhorse?" In vetoing an educational bill the governor of a state recently said that educational expenditures had increased by 130 per cent since 1913. That is the truth, but not the whole truth. The rest of it is that when buying power of the dollar and number of pupils are taken into account, the schools of that state are not as well supported now as they were in 1913. The people of the United States, and especially those of the Pacific Northwest, are far more able to support education than ever before. But modern conditions have put education at a decided disadvantage in securing its share of the consumers' dollars, particularly since the means for securing it, the general property tax, has broken down. Real estate is left to boost the educational piano upstairs, while to the wealthy owner of intangibles, the idea

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Phenology an Instrument of Forest Administration[1]

By

ERNEST L. KOLBE

Pacific Northwest Forest Experiment Station

THE use of plants as seasonal indicators dates back to early periods of civilization. In the last century the ancient method of reading nature's calendar from plants fell into disrepute, probably due to the increased interest of scientific workers in instrumental data and the need for greater refinement in these observations. However, the hopelessness of segregating and measuring instrumentally the many factors involved in plant growth was soon realized, along with the prohibitive cost of the many mechanical devices that such an attempt requires. This led us to return to the use of phenological observations, though with modifications and, we hope, with the necessary improvements on the older methods to satisfy our present needs. It is my purpose in this paper to indicate some of the practical scientific facts and uses that may result from phenological observations and how such observations are made by the Pacific Northwest Forest Experiment Station and its cooperators.

Historical Outline

Phenological observations in the forest have for many years been conducted in various European countries. In the United States there has been comparatively little systematic recording of biotic events of forest vegetation, although the need for them has been repeatedly mentioned in the literature. Observations on farm crops have not been so neglected. About twenty years ago a beginning was made by the Forest Service through its officers and cooperative observers. Sufficient observations were made to warrant the publication of "A Calendar of the Leafing, Flowering, and Seeding of the Common Trees of Eeastern United States." In the west not enough data were collected for publication. The system used at that time did not result in satisfactory records, as no correlations could be made between periodic phenomena and other conditions, such as climate. The project was, therefore, dropped until 1927 when the Pacific Northwest Forest Experiment Station began making observations in the Douglas fir region. Since then several other federal forest experiment stations have undertaken the project. Mention should also be made of the work on seasonal development or range plants which has been carried on for some years by the Forest Service through its office of Range Management. Some of the records have been published in bulletin form under the title "Grazing Periods and Forage Production on the National Forests." The Bureau of Entomology in research work on forest insects has kept records of biotic events of forest plants as they

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Some Matters of Finance

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of carrying an educational spool of thread makes him feel abused, as if he were taken for a packhorse.

Nothing is finally settled until it is settled right. In the settlement of the present tax muddle the Washington Education Association will have an influential part. It deserves the loyal support of every teacher. With such support it can lessen the loss which education and teachers will otherwise suffer.

are related to the life cycle of insects. Hopkins' bioclimatic law resulted from this work.

The Purpose of Phenology

Present needs have somewhat changed the aims and uses for recording phenological observations. Scientific significance as well as academic interest is given to the date that forest trees and their associated plants vegetate, bloom, and ripen fruit. Therefore, the attempt in this study is primarily to aid forest management to determine the mutual relationship of life events with such factors as temperature and rainfall. The work is usually restricted to the solution of special problems. In forest research the biotic events may be successfully used to determine the effect of climate on plant growth; variations in local climate; any relationship they have to each other as well as to environment. Also, in such a study one may well inquire into the growth habits of forest trees and plants and determine how they are related to fire hazard, insect and fungus control, logging operations, and recreation.

The need for phenological information in forestry is apparent. In the introduction of exotics or the range extension of native species, it becomes more and more essential to have definite knowledge of plants and their habits with respect to environment. Also it is known that throughout the world reforestation programs are on the increase; that the best source of seed and the species to be planted are real problems to nearly every forest administrator. Phenology supplies data that will make possible a comparison of site and throw light on the requirements of certain indicator plants. Likewise a basis for the prediction of seasonal phenomena will be helpful in cone collecting, in rodent, insect and fire control. Recently a pulpmill operator used phenological records to determine the period when he could most easily peel Sitka spruce bark. Again by means of phenological data the tourist may best plan his trip to park or forest at the height of the growing season, or at a time when certain plants are blooming. Truly, phenological records are fundamental to many problems in forest use.

The Project in the Douglas Fir Region

The project in the Douglas fir region contemplates observations of the principal coniferous trees, several deciduous trees, and a number of well distributed and characteristic shrubs, and herbaceous plants. The specimen plants to be natural grown, free from artificial interference, and in sites characteristic of the locali.ty.

Generally, each event recorded for a species will be based on the observation of a considerable number of individuals. That is, a few plants are carefully examined and the results checked against the growth conditions of a large number of the same species, so as to guard against abnormal individuals.

Since the records are valuable in proportion to the number of years over which they extend, it is essential that a permanent observation point is selected. For best results it must also be convenient to the observer, preferably near a Weather Bureau Station, homogeneous, and contain at least several of the chosen set of indicator plants.

Obviously, the observer is the all important factor in phenological work. Upon his judgment depends the whole plan. It is fortunate if he has a naturalist's enthusiasm for living things and will implicitly follow the directions set forth in the working plan. This requires visiting the area regularly at

1. Presented at the annual meeting of the Northwest Scientific Association, December 29, 30, 1930, Spokane, Washington.

least once a week throughout the growing season and observing the growth status of each species on the schedule. Where the observer is unacquainted with plants and the annual sequence of their activities, it usually takes one or more years of practice before dependable records are produced. Naturally, a beginner experiences real difficulty in making the observations. He has many details to remember and is not absolutely certain regarding his observation nor the identification of the several species. Nevertheless, it is true that anyone with patience can soon become so proficient that the weekly phenological work requires but little more than a stroll through the area.

Obviously to obtain data with very little effort the phenologist must have a set of simplified record forms and plans to guide him. In the Douglas fir region only the more common plants are listed on the schedule and only the more evident and easily seen life events are recorded. This makes possible the use of only three field forms for conifers, for broad-leaf trees and shrubs, and for herbaceous plants. This scheme has some disadvantages in that relationships could be more accurately determined with numerous observations on many plants. Nevertheless, from a practical standpoint, it seems to be the only workable method. This is especially true in the compilation of the data. With each station observing the same species of plants for the same life events the technic of tabulating the annual records in the office becomes a rather simple matter. For the project in the Pacific Northwest it has been the practice to gather in the field forms each December and transfer the data to cumulative record cards. The first step in this is to change the month dates of the field forms to year dates. That is, the date of an event is changed to the number of days it occurred from January 1 rather than to list a month and day as in the field forms. This makes possible easy comparisons of one year or station with another, shows clearly the sequence at which events occur and greatly simplifies any computations that are to be made. This scheme requires a separate card for each species at each station, which seems to be a very satisfactory system in that it simplifies the analyses of the yearly averages.

These comments regarding the study in the Douglas fir region are necessarily brief, as the project has been carried on less than half a decade, a period too short for sufficient trial of the method. Nevertheless, we feel justified in believing, that phenological data, with all that it implies, will in the near future become more and more a tool of the forester in the solution of his everyday problems.

The Ecological Distribution of the Pelecypoda In the Coos Bay Region of Oregon[1]

By
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NOT much attention has been given to the fauna of the Oregon coast, especially with reference to the Mollusca. The work of Edmondson (1922) dealt briefly with the shell fish situation in this region but largely from the practical and economic point of view. Other than this one finds only scattered references to the ecology and taxonomy of this group of animals on this particular portion of the Pacific Coast.

The Pelecypoda show such a wide range of structural adaptability in size, shape, length of siphon, character of shell, development of the foot, activity, i.e. whether attached, boring or burrowing, also in their various toleration limits that an ecological study of their distribution on the Oregon coast seemed desirable. Accordingly the following study in the Coos Bay region was made.

Coos Bay lies a little south of the midpoint of the Oregon coast. The region is fairly representative of the costal condition of the state and was the site of the University of Oregon Biological Camp for three years. It was during parts of the summer of 1925, '26, and '27 that the following investigation was carried on with special attention given to the problem from the middle of June to the latter part of July of the last two mentioned summers. The general findings of the biological classes are incorporated with our own data to form the basis of this report.

The following description used with the accompanying map should make clear an understanding of the general conditions. The entrance to Coos Bay is approximately 124° 20′ W., 43° 21′ N. The coast north of the bay is made up of a long, low, wind blown stretch of sandy beach, supporting very little plant or animal life. On the south the entrance to the bay is guarded by Coos Head, the north end of rugged cliffs 60 to 100 feet high, extending southward for many miles and broken only here and there by the valleys of small streams. Short stretches of sandy beach are found along the foot of the cliffs broken at intervals by mussel covered rocky promontories which jut out into the surf.

At frequent intervals reefs extend at right angles to the shore, for considerable distances into the sea. These reefs are of rather soft sandstone and shale, mostly of the Coaledo formation, much tilted and cracked, therefore broken and eroded by wave action. Often a considerable extent of the reef is accessible for collecting at low tide. The cracks, crevices, channels, varied tide pools, sand filled pockets, over hanging ledges of partially decayed rock and large and small boulders provide habitats for a great variety and quantity of animals and plants.

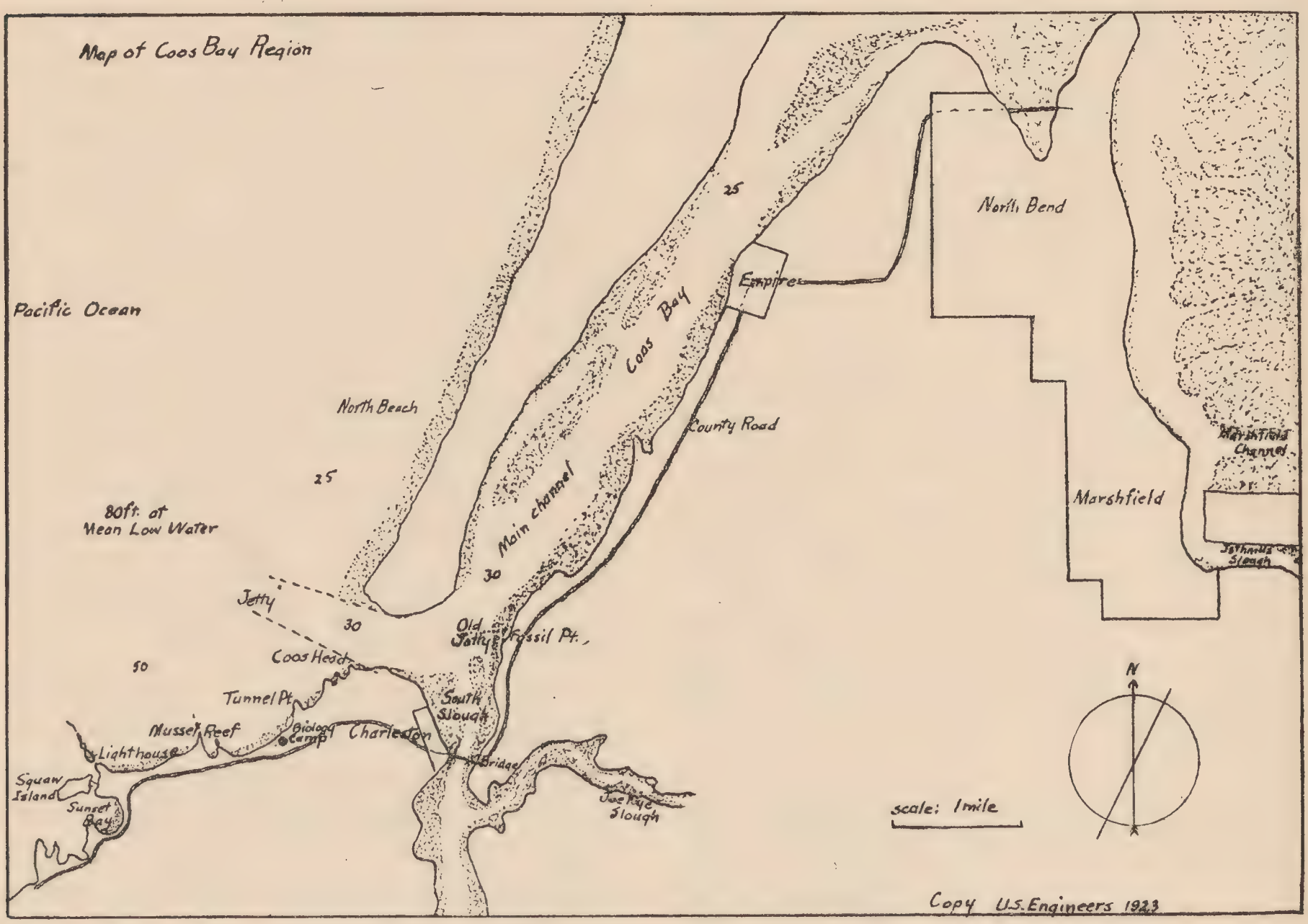
During the summer the prevailing winds are north-westerly and the drift of the current is toward the south. In winter, conditions are nearly the re-

1. Presented at the annual meeting of the Northwest Scientific Association, December 29, 30, 1930, Spokane, Washington.

verse, the heaviest storms come from the southwest.

The entrance to Coos Bay has been so narrowed by extensive jetty construction that strong tidal currents are produced. While the effects of these currents extend some distance up the bay, their scouring together with the constant dredging that is carried on make for more unsettled bottom conditions near the entrance.

The bay is V-shaped and rather narrow. It extends in a north-easterly direction about seven miles, then southerly for about the same distance. The Coos river flows into the upper end of the bay and a number of small streams enter the bay and sloughs at different points so that during the rainy season the salinity of the water is considerably reduced at low tide. One of the largest arms of the bay, South Slough, enters the main channel a short distance east of the inner end of the south jetty. Conditions along the banks and on the mud flats of South Slough are equivalent to those occurring in the several other sloughs that branch off the bay. The upper reaches of South Slough have a substrate of fine silt or clay mixed with some organic matter and is decidedly mushy and sticky. Near the mouth of the slough and where the tidal currents are active sand occurs. Sand bars and spits are more in evidence on the north side of the main channel of the bay than on the south side where more mud is deposited. Winds affect the tidal currents, these in turn affect the bottom, either by eroding or depositing, (the gentler the current the finer the material that is laid down), with the result that the bottom often shows a patchy character. General collecting in the whole region has demonstrated that the varied environmental condi-



tions support a large and varied marine fauna.

Frequent beds of empty shells of sand or sand and mud dwelling molluscs show where apparently freshets or changing channel currents have washed out clam beds. The *Schizothaerus, Saxidomus, Mya* and *Macoma* seem to experience great difficulty in getting back into normal position if laid on a rather firm substrate. The professional clam diggers in this locality say that it takes two or three years for a bed that has been washed out to reestablish itself. During the period of reestablishment there does not appear to be a definite succession of molluscs since there is seldom a fixed cycle of changing conditions although it is to be noted that as mud and silt settle on a bed, *Cardium* with its rudimentary siphon disappears while in pure mud only *Mya* seem to flourish.

Collecting was carried on in several ways and detailed field notes taken. On rocky beaches and ledges a short handled army pick was used to get under the algae and into the rocks. Where the boulders were small enough to manage they were turned over and the lower surface as well as underlying sand pockets examined. The underside of rocky ledges or shelves were also searched. Sand and gravel pockets between rocks were examined and a considerable quantity of their contents screened for small specimens. Digging and screening were carried on along the beaches and mud flows. Dredging was not employed but this method should yield quite a number of additional species.

The works of Oldroyd (1924, Packard (1918), and Keep (1911) were the references chiefly used in identification. Most of the material was later checked over with the assistance of Dr. E. L. Packard with named collections in the Condon Geological Museum of the University of Oregon.

A distributional and frequency chart will serve to show the relation of the pelecypod population to general regional conditions. The locations are geographical, habitats will have to receive separate consideration later since one location frequently, in fact usually does, have several types of habitats. Sunset Bay includes the rocks on each side of the entrance and the small sand beach in the bay. Squaw Island includes the projecting reef south of the one on which Cape Arago light is situated. Lighthouse Point takes in that point and the beaches on each side. From Mussel Reef or Yokam Point on around to Coos Head is included under Tunnel Point. The flats and bars south of Charleston Bridge are referred to as South Slough, those north of the bridge together with the bars and flats on each side of the channel are referred to as Lower Bay and Old Jetty.

The frequency numbers used represent the following: zero indicates the species was not found at that locality; 1 indicates rare, only a shell or two or perhaps a single living specimen was found at that locality; 2 indicates occasional, a few living specimens may be found if search is made under favorable tide conditions; 3 indicates frequent occurrence, specimens may be found in fair numbers; 4 indicates abundant, large numbers of specimens may be found without difficulty.

DISTRIBUTION CHART

Species	Sunset Bay	Squaw Island	Lighthouse Pt.	Tunnel Point	Lower Bay and Old Jetty	South Slough and Flats
Bankia setacea	0	0	0	0	3	3
Botula californiensis	2	2	2	2	2	1
Botula falcata	3	3	3	3	3	1
Cardium corbis	1	0	1	1	4	2-3
Cryptomya californica	0	0	0	0	2	1
Hinnites giganteus	2	2	1	0	0	0
Kellia laperousei	3	2	1	1	0	0
Lyonsia saxicola	2	2	2	1	0	0
Macoma balthica	1	0	0	0	3	2
Macoma inflatula	0	0	0	0	1	0
Macoma inquinata	2	0	1	0	3-4	2
Macoma inquinata arnheimi	0	0	0	0	2	1
Macoma nasuta	1	0	0	0	3	2
Marcia subdiaphana	0	0	0	0	1	0
Modiolus modiolus	0	1	1	0	0	0
Mya arenaria	0	0	0	0	3	4
Mytilus californianus	4	4	4	4	0	0
Mytilus edulis	1	1	2	1	3	2
Mytilimeria nuttallii	2	1	1	0	0	0
Ostrea lurida	1	0	0	0	1	1
Pecten hericius	2	1	1	0	0	0
Paphia staminea	2	2	1	1	4	3
Paphia staminea orbella	3	2	2	2	2	0
Paphia staminea ruderata	1	0	0	0	2	1
Pododesmus macroschisma	1	1	1	0	1	0
Pseudopythina rugifera	0	0	0	0	1	0
Psephidia brunnea	0	0	0	0	1	0
Petricola carditoides	3	3	2	2	2	0
Pholadidea penita	3	3	3	3	3	0
Pholadidea ovoidea	2	2	2	2	2	0
Pholadidea rostrata	1	1	0	0	0	0
Saxicava arctica	2	3	2	2	3	0
Saxicava pholadia	1	2	1	1	2	0
Saxidomus giganteus	2	0	0	0	3	3
Saxidomus giganteus brevis	0	0	0	0	1	0
Schizothaerus nuttallii	1	0	0	0	4	3
Siliqua patula nuttallii	0	0	0	3	2	0
Spisula falcata	0	0	0	0	1	0
Tellina bodegensis	0	0	0	1	0	0
Tellina salmonea	0	0	0	0	2	0
Zirfaea gabbi	0	0	0	0	3	0

As already mentioned the chart is good for general localities but the localities mentioned are made up of more than one habitat or association. Since it is the nature of the habitat that determines the species of mollusc to be found it is the important determiner of distribution, and so requires consideration in some detail.

All the habitats considered lie in the Littoral Zone (Cotton 1912). The term habitat in this paper is somewhat similar to Cotton's "formation" or Allee's (1923) "association." The most obvious, conspicuous and important factor is the character of the substrate and this is used in indicating the habitats. The dominant pelecypod of the habitat will be mentioned as well as the most common alga present. Since we did not obtain a satisfactory series of oxygen and p^H determinations our statements are based on the conclusions reached by Shelford (1916) and Allee (1923) in their investigation of comparable conditions.

The following habitats seemed definite enough considered from the pelecypod population, to be listed separately:

1. On Rocks.
2. In Rocks.
3. Rock protected.
4. Ocean sand-beach.
5. Bay sand.
6. Mixed sand and mud.
7. Mud flats.
8. Drift wood and piling.

On the rocks. Chiefly of the ocean shore. The environmental factors are: physical shock from the waves, plenty of oxygen from agitated water and from considerable vegetation, for the latter reason a p^H well to the alkaline side, plenty of light, temperature at times of low tide that rises far above that of the inundating water, periods of dessication attendant upon low tide exposure but modified by the amount of organic material that may tend to retain moisture. *Fucus* sp. is probably the dominant alga although in many places on rock surfaces adjacent to the mussel beds *Lammanaria* sp. predominates. The more exposed rocky reefs

support a fair growth of *Postelsia palfaeformis.*

Mytilus californianus, dominant.

Mytilus edulis, but more abundant on rocks in the bay.

These mussels seem to favor a vertical distribution from a little below mid tide level to a point even above high tide mark but subject to a slight wash of the waves.

In the rocks. Chiefly of the ocean shore, Sunset Bay to a short distance inside the entrance of Coos Bay. The rocks are rather soft in nature; sandstone and shales. The molluscs here considered include dwellers in crevices as well as borers. Physical characters in general similar to those found on the rocks except the wash of water and wave impact no longer act directly on the organisms, light is of course cut down, temperature increase and dessication during low tide exposure is lower than that of habitat just discussed. Oxygen content and p^H of the water probably little changed. Vegetation is similar in nature to that on the rocks with the addition of *Ulva* sp. and certain encrusting algae which crowd into crevices and borings.

Pholadidea penita (dominant, bor ing), *Pholadidea ovoidea, Pholadidea rostrata, Botula californiensis, Botula falcata, Petricola carditoides* (crevices or old borings), *Saxicava artica, Saxicava, pholadia, Kellia laperousei, Lyonsia saxicola, Paphia staminea orbella, Zirfaea gabbi* (boring, soft shale).

With reference to depth distribution among the boring forms *Zirfaea* bores to a foot or more while *Botula* and *Pholadidea rostrata* are just below the surafce. *Pholadidea penita* the dominant form goes down from six inches to one foot.

Rock protected. Under ledges and rocks, and in sand pockets among rocks. This habitat is well represented at Squaw Island and Old Jetty. Physical characteristics are practically the same as for "on the rocks" except that animal forms, while semi-exposed, are not able to withstand the direct wash of the waves. Many forms of algae are to be found in the protected tide pools.

Paphia staminea (sand), *Hinnites giganteus* (attached), *Mytilimeria nuttalli* (attached, covered by compound ascidian), *Modiolus modiolus* (attached or in sand), *Pecten hericius* (attached or free), *Pododesmus macroschisma* (attached), *Hinnites* and *Mytilimeria* were found only at extreme low tides.

Ocean Sand. All of this area was exposed to currents and wash of the waves so that no fine material was laid down. A long stretch of beach lies north of the entrance and two short beaches lie south of the entrance to the bay. The physical characteristics are: wave action and shifting sands, (the sand either being eroded or deposited) which tend to eliminate growth of vegetation. The agitated water probably well oxygenated while the p^H is somewhat less than where there is an abundance of growing vegetation. Light is abundant. Temperature and dessication effects are marked at the surface on low tide exposure but do not extend very deeply.

Siliqua patula nuttallii, dominant.

Bay sand. This habitat partakes of the nature of the ocean sand and of the mixed sand of the bay. While not subject to the pound of the surf currents shift the sand about and sweep any fine material away. This habitat is represented by beaches inside the jetty and along the north shore of the lower channel. There is less severe pounding than on the ocean beach. It is subject to salinity changes at different stages of the tide and at different seasons of the year, there is some pollution from sewage and harbor activities. Temperature and dessication

would be much the same as for the ocean beach. Little or no vegetation is present. It is very hard to draw a sharp line between this habitat and the "sand and mud" habitat, as many inhabitants of the latter live in the sand provided it does not shift about.

Cardium corbis, Siliqua patula nuttallii, Paphia staminea, Saxidomus giganteus, Schizothaerus nuttallii.

Depth distribution. *Cardium* on or close to surface, *Schizothaerus* deepest the others intermediate.

Sand and Mud. This habitat is in the quieter water but not so quiet that only silt and mud is deposited. There is usually considerable organic matter. There may be a rather patchy stratification of different materials. These conditions may be found along the south shore of the main channel and extending a mile or so up South Slough. The physical and chemical characteristics are: light somewhat reduced by material in suspension; oxygen content lower and p^H more acid than over the sand because of the presence of considerable decaying organic matter. The oxygen content is brought up some by the presence of considerable growing vegetation, considerable areas of eel grass *Zostera* sp. exist and *Ulva* sp. attaches itself to almost any support even to the siphon tips of the *Schizothaerus*. Temperature and dessication of low tide is kept down somewhat by the presence of overlying vegetation. Variety of species and density of population would indicate this to be the ideal habitat. The distribution of specias is as follows:

Schizothaerus nuttallii (most conspicuous), *Paphia staminae* (probably most numerous), *Cardium corbis, Cryptomya californica, Macoma balthica, Macoma inflatula, Macoma inquinata, Macoma inquinata arnheimi, Marcia subdiaphana, Ostrea lurida* (attached to some solid support), *Paphia staminea ruderata, Pseudopythina rugifera* (attached to abdomen of burrowing shrimp, *Gebia*),*Psephidia brunnea, Saxidomus giganteus, Saxidomus giganteus brevis, Spisula falcata, Tellina bodegensis, Tellina salmonea.*

With reference to depth distribution, *Ostrea* must remain above the mud or sand or be smothered, *Cardium* and some species of *Macoma* lie just under the surface while *Schizothaerus* and *Saxidomus* may be down a foot or more.

Mud Flats. Areas where the movement of the water is so slight that the finer material in suspension settles out, the fine silt and organic matter forms a sticky rather dense substrate. These areas occur where the upper bay widens out and in the sloughs, especially the upper part of South Slough. Drainage and fresh water streams carry in material in suspension and also affect the salinity more than in the lower parts of the bay. Light is reduced by the muddy water. In some places lower orders of algae form a patchy greenish scum on the mud; in general the oxygen content is low and the p^H tends towards acidity. Dessication is perhaps retarded somewhat by the nature of the substrate. The temperature rises due to long expasure and also remains warmer than lower parts of the bay.

Mya arenaria (dominant), *Paphia staminea, Cardium corbis, Macoma balthica, Macoma nasuta, Saxidomus giganteus, Schizothaerus nuttallii, Ostrea lurida.*

Drift Wood and Piling. This habitat can not be given definite location. When logs are jammed among wave washed rocks on the beach they tend to support forms similar to those attached to the adjacent rocks. In the bay the fauna of the piling and drift wood also varies with the location,

being governed by the physical and chemical factors of the area where it lies.

Bankia setacea (burrowing), *Mytilus edulis* (attached), *Ostrea lurida* (attached to any solid support, upper bay and sloughs).

Summary. The physical conditions found on the coast in the Coos Bay region are fairly representative of those occurring all along the Oregon coast.

The Pelecypoda by reason of their wide range of adaptations were found to inhabit every marine association or habitat of the region.

Habitats were classified according to the nature of the substratum.

The greatest variety as well as the densest population of pelecypods occurred on mixed mud-sand bottom. Other habitats with dense populations are: rock surfaces (*Mytilus californianus*) and mud flats (*Mya areanaria*).

This work was aided by a grant from the University of Oregon Research Committee.

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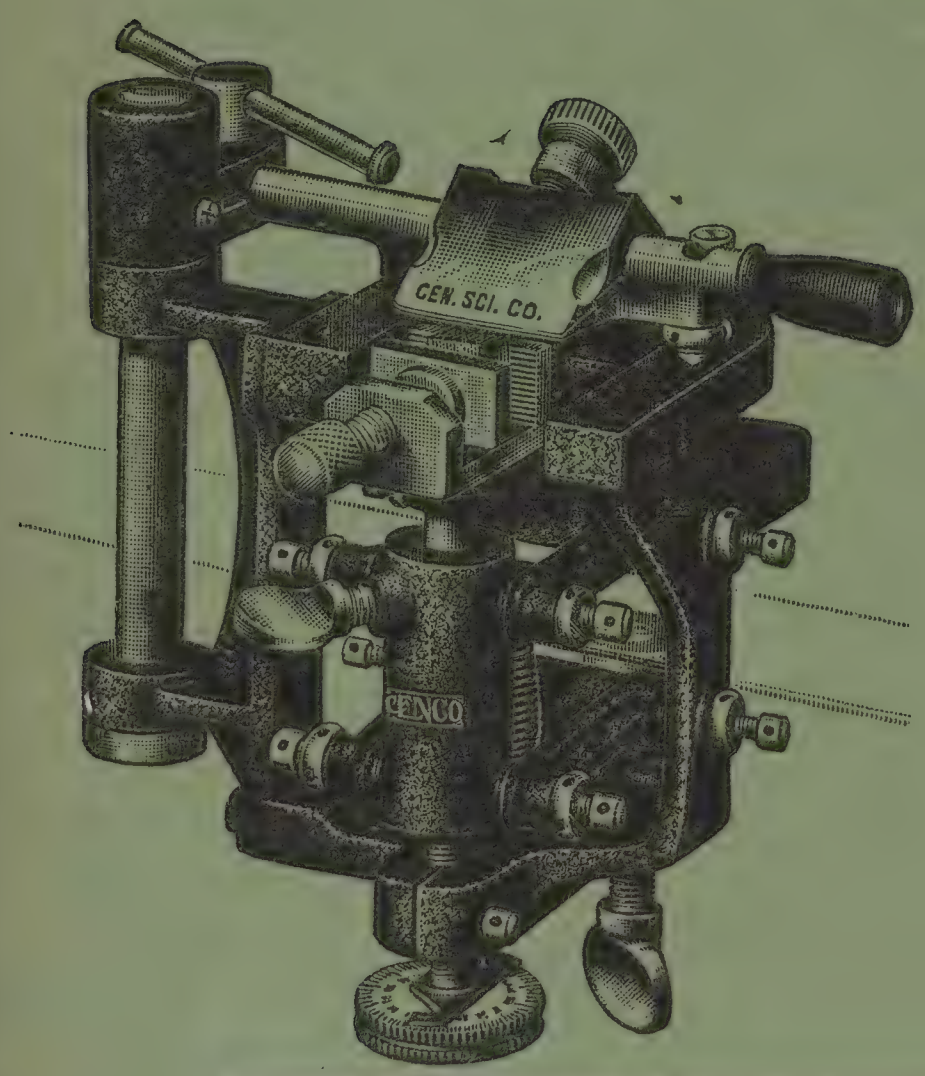

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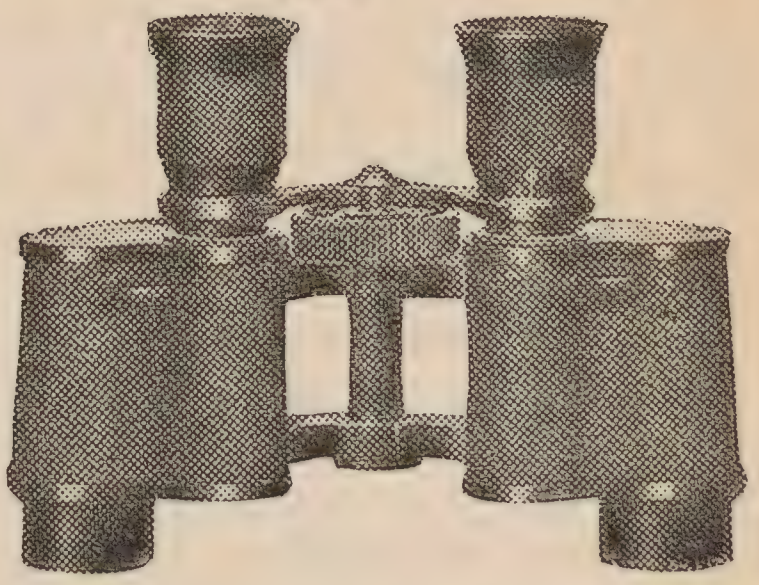

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Program of the Eighth Annual Meeting
of the
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December 29-30, 1931
Davenport Hotel Spokane, Washington

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REDUCED RATES FOR MEETINGS

A convention identification certificate will be sent to each member of the Association who resides outside the city of Spokane. This certificate, if presented to agent at starting point, will entitle a member to a round trip fare of one and one-third the regular one way fare. Dates of sale of such tickets will be December 26 to December 29; final return limit January 2.

MEMBERSHIP

Membership in the Association is open to any one paying the annual dues of one dollar. Members receive, without additional cost, the issues of Northwest Science, the official publication of the Association.

HEADQUARTERS

The Davenport Hotel will be the official headquarters of the Association and all meetings of the Association will be held in the hotel rooms.

REGISTRATION

The registration desk will be found on the Mezzanine Floor of the Davenport Hotel. All old members should register and receive their official badge for the meeting. At the same time they should see that their dues are paid. New members should fill out an application blank and pay the annual dues.

Registration will begin at 9:00 A.M., December 29 and will continue until the following noon. All are urged to register as early as possible.

ANNUAL DINNER

Luncheons--Breakfasts

The annual dinner will be held at 6:30 P.M. on Tuesday, December 29, in the Hall of the Doges. Reservations should be made at the time of registration. Price $1.50. Members and guests are invited to attend. The speaker of the evening will be Francis A. Thomson, retiring President of the Association. Subject "Research and College Teaching."

There will be a joint luncheon on Wednesday at 12 o'clock in the Elizabethan Rooms, the Associated Engineers of Spokane and the Northwest Scientific Association participating. Price seventy-five cents. Homer L. Shantz, President of the University of Arizona, will speak. Subject: "A Naturalist in Africa."

There will be a Sigma Xi breakfast for members and guests on Wednesday morning at 8 o'clock in the East Banquet Hall. Reservations should be made at the time of registration. Price, seventy-five cents.

Geologists and their friends will lunch together on Tuesday, December 29 in the Mandarin Room. Price seventy-five cents. Please make reservations at the registration desk.

SCHEDULE OF MEETINGS

Tuesday, December 29

9:00 A.M.—Registration, Mezzanine Floor.

10:00 A.M.—General Session, Elizabethan Rooms, A, B, C.

12:00 Noon—Geologists' Luncheon. Mandarin Room.

1:30 P.M.—Section Meetings.
Botany-Zoology. Elizabethan Rooms B, C.
Chemistry-Physics. Elizabethan Rooms D, E.
Education. Room 200.
Engineering. Elizabethan Room A.
Forestry. East Banquet Hall.
Geology-Geography. Mandarin Room.
Social Science. Hall of the Doges.

6:30 P.M.—Annual Dinner. Hall of the Doges.

Wednesday, December 30

9:00 A.M.—General Session. Business Meeting. Elizabethan Rooms A, B, C.

10:00 A.M.—Joint Session of Botany-Zoology, Chemistry, Engineering, Forestry and Geology-Geography Sections. Symposium on Climate. Elizabethan Rooms A, B, C.

12:00 Noon—Joint Luncheon with Associated Engineers. Elizabethan Rooms.

1:30 P.M.—Section Meetings.
Botany-Zoology. Elizabethan Room A.
Chemistry-Physics. Elizabethan Rooms D, E.
Education. Room 200.
Forestry. Mandarin Room.
Geology - Geography. East Banquet Hall.
Medicine-Surgery. Elizabethan Rooms B, C.
Social Science. Hall of the Doges.

GENERAL SESSIONS

Tuesday, December 29

10:00 A.M.—Elizabethan Rooms A, B, C.
President Ernest O. Holland presiding.
Address: "The Vegetation of the United States and its Relation to Agriculture"—Homer L. Shantz, President, University of Arizona.

6:30 P.M.—Annual Dinner. Hall of the Doges.
President Ernest O. Holland, Chairman.
Address of Retiring President, Francis A. Thomson, State School of Mines, Butte, Montana. Subject: "Research and College Teaching."

Wednesday, December 30

9:00 A.M.—Annual Business Meeting. Elizabethan Rooms A, B, C.
President Ernest O. Holland, Chairman.
Reports of Officers and Committees.
Election of Officers.

12:00 Noon—Joint Luncheon with Associated Engineers. Elizabethan Rooms B, C, D, E.
Address: "A Naturalist in Africa"—

Homer L. Shantz, President, University of Arizona.

SECTION MEETINGS

Botany-Zoology

Charles W. Waters, State University, Missoula, Montana, Chairman.
Charles E. Cone, Ephrata, Washington, Secretary.

TUESDAY, DECEMBER 29, 1:30 P.M.

Elizabethan Rooms B, C.

1. Characteristics of Northwest Forest Soils—W. L. Powers, State College, Corvallis, Oregon. 10 Minutes.
2. Sclerotium Diseases of Grains and Grasses—Ruth Remsberg, University of Idaho, Moscow, Idaho. 30 Minutes.
3. The Wallowa Primitive Area—Thomas Large, Lewis and Clark High School, Spokane, Washington.
4. Moving Pictures of Western Rattle- 10 Minutes.

snakes—J. W. Hungate, State Normal School, Cheney, Washington. 15 Minutes.

5. Some Observations on Lichens as Factors in Northern Rocky Mountain Forest Succession—Howard R. Flint, U. S. Forest Service, Missoula, Montana. 20 Minutes.
6. Some Carbohydrase Relations in Leaves of Healthy and Diseased Tobacco—J. W. Severy, State University, Missoula, Montana. 30 Minutes.

WEDNESDAY, DECEMBER 30.

10:00 A.M.—Joint Session — Symposium on Climate. Elizabethan Rooms A, B, C.

1:30 P.M.—Elizabethan Room A.

1. Business Session.
2. Adaptation of Wheat Varieties in the Pacific Northwest—E. F. Gaines and E. G. Schafer, State College, Pullman, Washington. 20 Minutes.
3. Rock Gardens and City Pools—R. A. Jones, Spokane, Washington. 15 Minutes.
4. Strange Misbehaviour of a Cougar—Thomas Large, Lewis and Clark High School, Spokane, Washington. 15 Minutes.
5. Some Quantitative Studies in Plant Succession—Floyd W. Gail, University of Idaho, Moscow, Idaho. 15 Minutes.
6. Some Parasites of White Pine Blister Rust—E. E. Hubert, University of Idaho, Moscow, Idaho. 15 Minutes.
7. Essays by prize winners in National Scientific Essay Contest sponsored by American Association for Advancement of Science.
   (a) The Importance of the Protozoa and my Studies With Them—Ralph Lawrence, Lewis and Clark High School, Spokane, Washington.
   (b) My Experiments with Hydra—Dunbar Triplett, Jr., Lewis and Clark High School, Spokane, Washington.
8. Some New Plants Found in Idaho and Their Ecological Significance—Vada Allen, University of Idaho, Moscow, Idaho. 10 Minutes.

Chemistry-Physics

B. C. Neustel, Whitworth College, Spokane, Washington, Chairman.
Rudolf Meyer, Lewis and Clark High School, Spokane, Washington, Secretary.

TUESDAY, DECEMBER 29

1:30 P.M.—Elizabethan Rooms D, E.

1. Problems Encountered in the Electrolytic Reduction of a Dinitrocresol—F. O. Gibson and W. E. Bradt, State College, Pullman, Washington. 10 Minutes.
2. A Quantitative Study of Skraup's Quinoline Synthesis—J. A. Kostalek, University of Idaho, Moscow, Idaho. 10 Minutes.
3. Cyclic Diselenides—J. F. Green and W. E. Bradt, State College, Pullman, Washington. 10 Minutes.
4. Influence of Gases on Stability of Zsigmondy Gold Sol—William C. Cone, University of Idaho, Moscow, Idaho. 10 Minutes.
5. Mineral Oil in Medicine, Pharmacy and Cosmetics—A. F. Maxwell, Maxwell Laboratories, Spokane, Washington. 15 Minutes.
6. Micro Kjeldahl Method for Protein in Cereal Products—J. A. Shellenberger, University of Idaho, Moscow, Idaho. 10 Minutes.
7. Properties of Single Zinc Crystals—Paul A. Anderson, State College, Pullman, Washington. 15 Minutes.

WEDNESDAY, DECEMBER 30

1:30 P.M.—Elizabethan Rooms D, E.

1. Business session.
2. The Electrochemical Reduction of 2-4 Dinitrophenol—W. E. Bradt, State College, Pullman, Washington. 15 Minutes.

3. Adsorption of Ions by Finely Divided Metal—Otto Turinsky, University of Idaho, Moscow, Idaho. 10 Minutes.
4. Oriental Mathematics—D. L. Soltau, Whitworth College, Spokane, Washington. 25 Minutes.
5. A Light Telephone—G. W. Hammar, University of Idaho, Moscow, Idaho. 15 Minutes.
6. A Study of the Peroxy-Acids of Sulfur (a) Stability of Aqueous Solutions, (b) Analysis—L. I. Gilbertson, State College, Pullman, Washington. 15 Minutes.
7. Volumetric Determination of Sodium—D. W. Bolin, University of Idaho, Moscow, Idaho. 10 Minutes.

Education

Raymond F. Hawk, State College, Pullman, Washington, Chairman.
I. N. Madsen, State Normal School, Lewiston, Idaho, Secretary.

TUESDAY, DECEMBER 29

1:30 P.M.—Room 200.

1. Factors of Success in Cadet Teaching—Lela Lavin, State Normal School, Cheney, Washington.
   H. H. Fuller, State College, Pullman, Washington.
   Discussion.

WEDNESDAY, DECEMBER 30

10:00 A.M.—Room 200.

1. Measurement of Teaching Success—I. N. Madsen, State Normal School, Lewiston, Idaho.
   O. C. Pratt, Spokane, Washington.
   C. W. Stone State College, Pullman, Washington.
   Discussion.

1:30 P.M.—Room 200.

1. Business session.
2. Studies in Psychology—Helen Richardson, State College, Pullman, Washington. 30 Minutes.
3. Scientific Essay Contests—Thomas Large, Lewis and Clark High School, Spokane, Washington. 15 Minutes.

Engineering

Richard McKay, Washington Water Power Company, Spokane, Washington, Chairman.
Ellery Fosdick, Washington Water Power Company, Spokane, Washington, Secretary.

TUESDAY, DECEMBER 29

1:30 P.M.—Elizabethan Room A.

1. Business session.
2. Trends in Precipitation and Runoff in the Columbia Basin Drainage Area—G. L. Parker, U. S. Geological Survey, Tacoma, Washington. 35 Minutes.
3. Case Hardening of Steel by the Nitriding Process—Theodore Boehme, State College, Pullman, Washington. 15 Minutes.
4. The Thermal Properties of Water—H. F. Gauss, University of Idaho, Moscow, Idaho. 30 Minutes.
5. Progress in Domestic Heating Investigations—H. J. Dana and H. H. Langdon, State College, Pullman, Washington. 15 Minutes.
6. Fatigue in Metals and in Electric Welds—Guy E. Thornton, State College, Pullman, Washington. 15 Minutes.

Forestry

J. H. Ramskill, State University, Missoula, Montana, Chairman.
Kester D. Flock, U.S. Forest Service, Missoula, Montana, Secretary.

TUESDAY, DECEMBER 29

1:30 P.M.—East Banquet Hall.

1. Announcement of the Purpose and Scope of the Symposium Subject—Climatic Variations and Their Effect on Forestry and the Forests of the Northwest—Chairman.
2. Inter-relation of Climate, Forests and Water Resources—L. F. Watts, Northern Rocky Mountain Forest Experiment Station, Missoula, Montana. 20 Minutes.
3. Some Notes on Precipitation Changes in Western Montana—T. C. Spaulding, State University, Missoula Montana. 25 Minutes.
4. Some Climatic Effects on Forest Growth and Regeneration—R. H. Weidman, Northern Rocky Mountain Forest Experiment Station. 15 Minutes.
5. Influence of Climate on Fire Protection in the National Forests of the Northern Rocky Mountains—Howard R. Flint, U. S. Forest Service, Missoula, Montana. 20 Minutes.

WEDNESDAY, DECEMBER 30

10:00 A.M.—Joint Section Meeting. Symposium on Climate. Elizabethan Rooms A, B, C.

1:30 P.M.—Mandarin Room.

1. Business session.
2. Climate as a Factor in the Range Livestock Industry—L. C. Hurtt,

U. S. Forest Service, Missoula, Montana. 20 Minutes.

3. Some Climatic Effects on Forest Tree Diseases—E. E. Hubert, University of Idaho, Moscow. Idaho. 20 Minutes.
4. Climatic Effect on Control of White Pine Blister Rust—H. P. Barss, State College, Corvallis, Oregon. 20 Minutes.
5. Climate and Forest Insects in the Inland Empire—J. C. Evenden, U. S. Bureau of Entomology, Coeur d'Alene, Idaho. 15 Minutes.
6. Effect of Climate on Wild Life—Glenn Smith, U. S. Forest Service, Missoula, Montana. 15 Minutes.

Geology-Geography

Otis W. Freeman, State Normal School, Cheney, Washington, Chairman.

F. B. Laney, University of Idaho, Moscow, Idaho, Secretary.

TUESDAY, DECEMBER 29

1:30 P.M.—Mandarin Room.

Miscellaneous Papers

1. Some Recent Geological Studies—Mr. Thomson, State College, Pullman, Washington. 15 Minutes.
2. The Columbia Plateau as a Type Study of Human Use Areas Based Upon Climatic Control—J. Wright Baylor, Mesa, Washington. 10 Minutes.

Problems in Cenozoic Geology of the Inland Empire

IDAHO

3. Tertiary Igneous Activity in Idaho and Adjoining Regions—Alfred L. Anderson, University of Idaho, Moscow, Idaho. 20 Minutes.
4. Tentative Correlation of the Tertiary Strata in Parts of Idaho, Wyoming, Utah, Oregon, Nevada and Washington—John T. Carpenter, University of Idaho, Moscow, Idaho. 30 Minutes.
5. Overthrust Faulting in Western and Central Idaho—D. C. Livingstone, University of Idaho, Moscow, Idaho. 45 Minutes.
6. Clays of Tertiary Age in Northern Idaho and Eastern Washington—Edward L. Tullis and F. B. Laney, University of Idaho, Moscow, Idaho. 20 Minutes.

WEDNESDAY, DECEMBER 30

10:00 A.M.—Joint meeting of Botany-Zoology, Chemistry, Engineering, Forestry and Geology-Geography Sections. Symposium—"Climate and its Relation to Science in the Inland Empire." Elizabethan Rooms A, B, C.

1. Fifty Years of Weather in the Inland Empire—Otis W. Freeman, State Normal School, Cheney, Washington. 10 Minutes.
2. Relation Between Tree Growth and Weather—W. B. Hampson, Omak, Washington. 15 Minutes.
3. Periodic Fluctuation of Rainfall in the Inland Empire—H. T. Gisborne, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana. 20 Minutes.
4. Influence of Climate on Washington Agriculture—Edward C. Johnson, State College of Washington, Pullman, Washington. 15 Minutes.
5. Serious Erosion Caused by Heavy Rain of July 30, 1931, Near Colfax, Washington—W. A. Rockie, Pacific Northwest Soil Erosion Station, Pullman, Washington. 10 Minutes.
6. Recent Forest Fire Weather—Francis C. Crombie, Weather Bureau, Spokane, Washington. 10 Minutes.

1:30 P.M.—East Banquet Hall.

1. Business session.

Problems in Cenozoic Geology of the Inland Empire

MONTANA

2. Recent Developments in Montana Gas Fields—Eugene S. Perry, State School of Mines, Butte, Montana. 15 Minutes.
3. Structure of a Portion of the Northern Rocky Mountains in Montana—Charles H. Clapp and C. F. Deiss, State University, Missoula, Montana. 20 Minutes.

OREGON

4. Five Years of Progress in Oregon Geology—Edwin T. Hodge, University of Oregon, Eugene, Oregon. 15 Minutes.
5. Some Phases of Cenozoic Geology in Eastern Oregon—Ralph L. Lupher, State College, Pullman, Washington. 20 Minutes.

WASHINGTON

6. History of Grand Coulee—J. Harlen Bretz, University of Chicago, Chicago, Illinois. 12 Minutes.
7. Recent Work on the Columbia River Basalts—Melvin G. Hoffman, State College, Pullman, Washington. 20 Minutes.
8. A Study of Tertiary Rocks Near Leavenworth, Washington—Everett Hougland and Mr. Parrott, State College, Pullman, Washington. 15 Minutes.

Medicine-Surgery

Dr. C. M. Anderson, Spokane, Washington, Chairman.
Dr. Clarence Lyon, Spokane, Washington, Secretary.

WEDNESDAY, DECEMBER 30

1:30 P.M.—Elizabethan Rooms B, C.

1. Prenatal Care and Birth Control—Dr. E. J. Lawrence, Spokane, Washington. 20 Minutes.
2. Necessary Food Requirements in the School Child—Dr. Frederick R. Fischer, Spokane, Washington. 20 Minutes.
3. Eat and be Happy—Discussion of "Allergy"—Dr. Robert F. E. Stier, Spokane, Washington. 20 Minutes.
4. "Squint"—Dr. David Hartin, Spokane, Washington. 20 Minutes.
5. Moving Picture Films—
   a. Lewis-Gregory Film of "The Early Develpoment of the Rabbit Egg."
   b. Lewis Film of "Normal Cells in Tissue Culture"—Dr. S. E. Lambert, Spokane, Washington. 30 Minutes.

Social Science

T. S. Kerr, University of Idaho, Moscow, Idaho, Chairman.
Louis S. Livingstone, Lewis and Clark High School, Spokane, Washington, Secretary.

TUESDAY, DECEMBER 29

1:30 P.M.—Hall of the Doges.

1. Socio-Economic Basis of Japan's Foreign Policy—Fred R. Yoder, State College, Pullman, Washington. 30 Minutes.
2. Training for Practical Citizenship—H. L. Talkington, State Normal School, Lewiston, Idaho. 30 Minutes.
3. Impressions of Russia—Thomas T. Kerl, Coeur d'Alene, Idaho. 30 Minutes.

WEDNESDAY, DECEMBER 30

10:00 A.M.—Hall of the Doges.

1. De Boss vs. De Barrel—Herman J. Deutsch, State College, Pullman, Washington. 30 Minutes.
2. Educational and Industrial Problems of Mexico—Lillian A. Seigler, Lewis and Clark High School, Spokane, Washington. 30 Minutes.

1:30 P.M.—Hall of the Doges.

1. Business session.
2. The Oregon Memorial of 1838—C. J. Brosnan, University of Idaho, Moscow, Idaho. 30 Minutes.
3. Unemployment Problems and How They are Being Met—C. K. Warne, Spokane, Washington. 30 Minutes.

A Review of the Existing Methods for the Preparation of Selenic Acid[1]

By L. I. GILBERTSON
State College of Washington

THIS review is the first of a series planned to review and coordinate the literature of the inorganic compounds of selenium. It is hoped that this work may assist and encourage research in this field.

The oxidation of selenium to the hexavalent state can be effected only by the use of very active oxidizing agents. As the anhydride of selenic acid is prepared with extreme difficulty (if at all), selenic acid must be prepared in aqueous solution by a less direct method than that of the interaction of the anhydride and water. Another difficulty encountered in the preparation of selenic acid is that of concentration of the acid as selenic acid is easily decomposed by heat and traces of reducing agents. Because of these difficulties, many methods have been developed for the preparation of selenic acid. Hopkins, (1) says that the best method yet described is that of Morris (cf. Division B, section 7). As this method involves the precipitation of the selenium as silver selenite it seems hardly applicable to large scale production.

Lenher (2) has stated that the industries of the United States could produce 300,000 pounds of selenium anually without making any material additions to present plants. Of this potential resource perhaps not more than one third is used annually. It would seem that the development of a simple large scale process for the preparation of pure concentrated selenic acid should result in the development of uses for the acid and the selenates.

The methods described in this review have been classified according to the oxidizing agent used.

A. Alkali Nitrate Fusions.

1. Mitscherlich (3) first prepared selenic acid in 1827 by the following method: H_2SeO_3 was neutralized with Na_2CO_3 and the solution of Na_2SeO_3 evaporated to dryness, mixed with $NaNO_3$ and ignited. The melt was extracted with water and the Na_2SeO_4 purified by repeated crystallizations. $PbSeO_4$ was precipitated from the aqueous solution of Na_2SeO_4 by the addition of $Pb(NO_3)_2$. The resulting $PbSeO_4$ was suspended in H_2O and H_2S passed through the solution. The H_2SeO_4 was separated from the PbS by filtration and the H_2SeO_4 concentrated by evaporation. The product was contaminated by $PbSeO_4$ and sodium salts. This method was also used by Berzelius (4). Wohlwill (5) observed that the $PbSeO_4$ was not completely decomposed by H_2S. Von Gerichten (6) described a method by which $PbSO_4$ might be removed from $PbSeO_4$ before treating with H_2S, thus avoiding any contamination of H_2SO_4. The method was reviewed also by Fabian (7).

2. Von Hauer (8) in 1860 fused SeO_2 with KNO_3, extracted the melt with HNO_3, prepared $CaSeO_4$ solution and purified the $CaSeO_4$ by crystallization. CdC_2O_4 was added to the aqueous solution of $CaSeO_4$ and the resulting $CdSeO_4$ separated from CaC_2O_4 by filtration. The $CdSeO_4$ solution was treated with H_2S to form CdS and

1. Presented at the annual meeting of the Northwest Scientific Association, December 29, 30, 1930, Spokane, Washington.

H_2SeO_4. The H_2SeO_4 was concentrated by evaporation. The advantage of this method lies in the fact that the Cd is quite completely removed as the sulfide and that the CdS does not readily oxidize, as does CuS, and contaminate the selenic acid. The objection to the method is its tediousness.

3. Lenher (9), in 1902, fused SeO_2 with KNO_3, extracted the melt with H_2O and precipitated $PbSeO_4$ by the addition of $Pb(NO_3)_2$. The $PbSeO_4$ was suspended in H_2O and treated with H_2S to form H_2SeO_4 and PbS. The H_2SeO_4 was concentrated by evaporation on a water bath. The method differs but little from that of Mitscherlich, and is open to the same criticisms.

B. Oxidation by means of Halogens.

1. Rose (10), in 1839, prepared H_2SeO_4 by passing chlorine through a solution of H_2SeO_3. The resulting solution containing H_2SeO_4 and HC1 was concentrated by evaporation. Topsoe (11) observed that this reaction is slow and incomplete and that concentration of the resulting product to any degree caused reduction of the H_2SeO_4 by means of the HC1 in solution thus contaminating the product with H_2SeO_3.

2. Berzelius (4) oxidized a solution of K_2SeO_3, alkaline with KOH, by means of chlorine—precipitated $PbSeO_4$ by the addition of $PbC1_2$, and then treated the $PbSeO_4$ with H_2S to prepare H_2SeO_4.

3. Wohlwill (5), in 1860, neutralized H_2SeO_3 with $CuCO_3$ and oxidized the $CuSeO_3$, with chlorine, to $CuSeO_4$. The $CuSeO_4$ was precipitated by addition of alcohol and purified by recrystallization. The $CuSeO_4$ was dissolved in H_2O and treated with H_2S to prepare H_2SeO_4. Topsoe (11) criticized this method, pointing out the fact that the CuS is oxidized easily to $CuSO_4$ and the resulting acid is invariably contaminated.

4. Thomsen (13), in 1869, neutralized H_2SeO_3 with Ag_2CO_3. The Ag_2CO_3 was suspended in water and oxidized by the addition of bromine. The precipitated AgBr was removed by filtration from the H_2SeO_4. However, some HBr is formed by the action of the bromine on the water. The HBr reduces some H_2SeO_4 thus contaminating the product with selenious acid. Lenher and Kao (12), overcame this difficulty by precipitating Ca, Ba, Sr, or Pb selenate and decomposing these to form selenic acid.

5. Metzner (14), in 1898, oxidized H_2SeO_3 with chlorine in the presence of CuO, forming $CuC1_2$ and $CuSeO_4$. The copper selenate was separated from the copper chloride by fractional crystallization. The purified $CuSeO_4$ was dissolved in water and the solution electrolyzed to remove the copper. Very pure H_2SeO_4, free from copper, chlorine and selenious acid was prepared by this method. Bromine was also used in this reaction but the oxidation was found not to be as complete as when chlorine was used.

6. Diemer and Lenher (15), in 1910, and Benger (16), in 1917, suggested the use of H_2S to remove the H_2SeO_3 contamination by reducing the selenious acid to selenium which could be removed by filtration. However, Dennis and Koller (17), in 1919, reported that H_2S also reduces selenic acid and hence cannot be used to remove the selenious acid as suggested by Diemer and Lenher, and Benger. Diemer and Lenher, according to Dennis and Koller, reported that the method they described produces selenic acid free from H_2SO_4 and H_2SeO_3. However, Dennis and Koller report that they failed to obtain selenic acid free from sulfuric acid and selenious acid by this method.

7. Morris (18), in 1912, modified Thomsen's method as follows: Selenium dioxide was heated with $AgNO_3$ to precipitate Ag_2SeO_3. The precipitated silver selenite was suspended in water and oxidized with bromine. The excess bromine was boiled off and H_2S added to reduce any H_2SeO_3 present. The H_2S was boiled off and the selenic acid concentrated by evaporation. This method is open to the same criticism as the methods of Diemer and Lenher, and Benger (cf. Sec. 6).

8. Dennis and Koller (17), in 1919, modified Thomsen's method to avoid the formation of much H_2SeO_3 by the reducing action of the halogen acids present in the reaction. Silver nitrate was added to selenious acid to precipitate the insoluble silver selenite. Sodium carbonate was added to the solution to prevent reversal of the reaction and thus insure more complete reaction. The resulting silver selenite was suspended in water and bromine water added to a slight excess. This excess of bromine was removed by addition of sufficient silver nitrate, the excess of which was removed by the addition of a little bromine water. The excess of bromine water was removed at once by boiling. The resulting solution was concentrated at 25 mm. pressure and a temperature of 120 degrees Centigrade.

9. Dennis and Koller (17), also modified the method of Rose. H_2SeO_3 was oxidized by chlorine and $CuCO_3$ added to form $CuSeO_4$. The copper selenate was crystallized out of solution and the occluded copper chloride removed by treatment with acetone. The purified copper selenate was dissolved in water and the solution electolyzed to remove the copper. The resulting solution of selenic acid was concentrated at 23 mm. and 95° C. Dennis and Koller reported that at temperatures as high as 175° C. some of the selenic acid is reduced to selenious acid and thence to selenium.

C. Oxidation by means of the Halogen Oxyacids.

1. Blumenthal (19), in 1913, oxidized selenious acid by means of $KBrO_3$ in nitric acid solution. The bromine formed in the reaction was boiled out and $BaSeO_4$ precipitated by the addition of $BaCl_2$. The precipitated barium selenate was treated with H_2SO_4 to form selenic acid and barium sulfate. The barium sulfate was removed by filtration.

2. Gooch and Blumenthal (20), in 1913, varied the method of Blumenthal by neutralizing the selenic acid solution with ammonium hydroxide and then precipitated $BaSeO_4$ by the addition of $Ba(NO_3)_2$.

3. Meyer and Moldenhauer (21), in 1921, oxidized selenious acid with $HClO_3$, evaporated the solution somewhat, filtered, and concentrated the selenic acid under reduced pressure at 50-60 degrees Centigrade. The final concentration was made at 150° C. and 50-60 mm. pressure. The product was contaminated by chlorine and $Ba(HSeO_4)_2$. These impurities were removed by dilution and reconcentration at a temperature below 150° C.

D. Oxidation by means of the Permanganates.

1. Metzner (14), in 1896, oxidized selenious acid by means of $HMnO_4$. The Mn_2O_3 formed in the reaction was removed by filtration and the acid concentrated. The acid was contaminated by selenious acid and traces of Mn_2O_3. Metzner also oxidized selenious acid by means of $KMnO_4$, filtered off the precipitated Mn_2O_3, and treated the solution of K_2SeO_4 with H_2SiF_6. The precipitated K_2SiF_6 was filtered off and the selenic acid solution concentrated by evaporation. Metzner observed that the oxidation of selenious acid by means of the permangan-

ates was quantitative. Mathers (22), in 1908, studied the method of Metzner using $KMnO_4$ in nitric acid solution as the oxidizing agent.

E. Oxidation by means of the Peroxides.

1. Blumenthal (19), in 1913, fused SeO_2 with Na_2O_2 in a nickel crucible, extracted the melt with water and evaporated the solution, containing Na_2SeO_4 and NaOH, to dryness. The NaOH was removed by extraction with alcohol and the residue of sodium selenate purified by crystallization.

2. Meyer and Heider (23), in 1915, fused SeO_2 with Na_2O_2 in a porcelain crucible, extracted the melt with water, and saturated the solution with CO_2. The aluminum present as an impurity from the crucible was precipitated as the hydroxide and the Na_2CO_3 separated from the Na_2SeO_4 by crystallization.

3. Fonzes-Diacon (24), in 1901, reported the formation of selenic acid when selenium is treated with concentrated hydrogen peroxide.

4. Meyer and Heider (23), in 1915, heated SeO_2 on a water bath with 30% hydrogen peroxide and obtained 40-70% yields of selenic acid.

5. Huff and McCroskey (25), in 1929, refluxed selenium with 30% hydrogen peroxide for two hours and produced 89-91% yields of selenic acid.

6. Mathers and Graham (26) in 1929, heated a paste of PbO_2, SeO_2 and water at 100° C. and prepared $PbSeO_4$. They reported the conversion to be nearly quantitative. Selenic acid was prepared from the lead selenate by treatment with sulfuric acid.

F. Oxidation by means of Air and Ozone.

1. Lenher and Wechter (27), in 1925, heated selenites of K, Li, Na, Rb, Cs, Ba, and Sr in the air at temperatures between 700 and 825 degrees Centigrade. The selenites were converted to the selenates. The time requird for the conversion was found to vary with the surface exposed to the air. Selenic acid was prepared by treating $HClO_4$ with K_2SeO_4, and by treating $BaSeO_4$ with H_2SO_4.

2. Maillfert (28), in 1882, oxidized selenium with ozone, in the presence of water, to selenic acid.

3. Worsley and Baker (29), in 1923, reported the formation of SeO_3 when a solution of selenium in selenium oxy-chloride was treated with 8% ozone. The reported SeO_3 dissolved in water to form selenic acid.

Cameron and Macallan (30), in 1890, had attempted such an oxidation without success.

Metzner (14), in 1896, concluded that the heat of formation of SeO_3 was less than that of SeO_2. Metzner attributed the endothermic nature of SeO_3 to be the reason why it had never been prepared.

Meyer and Pauletta, (31), in 1927, investigated the reaction of Worsley and Baker and obtained negative results.

Hoffman and Lenher (32), in 1929, investigated the method of Worsley and Baker and reported that under conditions identical to those of Worsley and Baker no selenium trioxide was formed. Hoffman and Lenher reported the substance formed to be precipitated selenium dioxide.

G. Electrolytic Methods.

The electrolytic methods for the preparation of selenic acid may be divided into two groups: 1. The removal of the metallic ion from solutions of the selenates by electrolysis, and 2. The electrolytic oxidation of selenites. Methods of the first type have been described: Metzner (Division B, sec. 5), Dennis and Koller (Div. B, sec. 9). Methods of the second type are:

1. Muller (33), in 1903, oxidized electrolytically a neutral solution of Na_2SeO_3 to Na_2SeO_4 using a platinum foil anode.

2. Glauser (34), in 1907, oxidized electrolytically a saturated solution of SeO_2 in HNO_3 to H_2SeO_4.

3. Meyer and Heider (23), in 1915, oxidized electrolytically a solution of SeO_2 in concentrated nitric acid to H_2SeO_4.

4. Manchot and Wirzmuller (35), in 1925, oxidized electrolytically a solution of SeO_2 in 5 Normal HNO_3.

A method which cannot be classified with either of the above types is that of Mathers (22) who, in 1908, decomposed $PbSeO_4$, which was resting on a platinum cathode in dilute selenic acid solution, forming in this manner selenic acid. Mathers reported an 87% yield.

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Juvenile Delinquency[1]

By
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TO the state of Illinois belongs the distinction of having enacted (June 1, 1899) the first specific law for the welfare of juvenile offenders. Discussing this enactment, Miss Julia C. Lathrop, Chief of the Federal Children's Bureau, said:

Certain provisions affected local Illinois conditions, but the features which have attracted universal attention have been of course, those of general application—the recognition of the delinquent child as a ward in chancery and not as an accused or convicted criminal, the separate court of children's cases, and the system of probation. Doubtless none of these provisions was an original conception, but the combination of a separate court, a separate place of detention for children, the abolition of fines, and the system of returning the child to his home and providing probation officers to help him there, was probably new. The rapid adoption of similar methods in other parts of the country and abroad was an almost simultaneous expression of a slowly matured, popular conviction that the growing child must not be treated by those rigid rules of criminal procedure which confessedly fail to prevent offenses on the part of adults or to cure adult offenders. Important as are the immediate services of a juvenile court to the children who are daily brought before it for probation and guidance, because the family protection has broken down and there is no family guidance, painstaking as are the court's methods of ascertaining the facts which account for the child's trouble, his family history, his own physical and mental state, hopeful as are the results of probation; yet the great primary service of the court is that it lifts up the truth and compels us to see that wastage of human life whose sign is the child in court. Heretofore, the kindly but hurried public never saw as a whole what it cannot now avoid seeing—the sad procession of little children and older brothers and sisters who, for various reasons cannot keep step with the great company of normal, orderly, protected children. Arnold Toynbee said: "If West London could know East London, there would be no East London;" and so in time we may believe, the picture presented by the juvenile court will by repeated emphasis so impress itself upon the mind of the town that new safeguards will be found for adequately protecting the most precious possession of the town —its young life.

The hope expressed by Miss Lathrop has indeed been realized. Due, undoubtedly, in large part to the educational effect of juvenile courts and their work, new agencies have been provided for the protection and guidance of children, prominent among these being the system of mothers' pensions, under which fatherless children may dwell together, with the mother, instead of being separated from her and scattered, or institutionalized by being housed and reared in orphanages; the Big Brother movement, and the adoption of health and recreational measures for the physical

1. Presented at the annual meeting of the Northwest Scientific Association, December 29, 30, 1930, Spokane, Washington.

and moral health of children, by municipalities, schools, fraternal orders, service clubs, and other official or unofficial organizations.

The delinquency of children is often attributable to poverty; but children who have formed habits of wrongdoing may be found in homes of every economic and social grade. Those in families of the wealthy or well-to-do are often guilty of the most serious offenses; and ordinarily it is their cases which are most difficult to explain. Sometimes it will be found that the wrong tendencies are inherited; more often the cause will be found to lie in over-indulgence of the child by the parent, lack of supervision and discipline, bad example on the part of one or both parents, or breakup of the home due to inharmonious marital relations.

One of the most common causes of delinquency, particularly in boys, is idleness—doing nothing and having nothing to do. The boy should be occupied, and his activities should not be one-sided—there should be work as well as play; a balancing of study and useful employment with proper recreations and pastimes. The first objective of the juvenile officer in the task of reforming a delinquent should be to see that the boy is usefully employed outside of school hours, in wholesome surroundings, and that he applies himself steadily and industriously to his work. When that objective is achieved, ultimate success is practically assured; and unless that objective is gained, the outcome will be failure.

In juvenile courts the school record of the child is deemed of high importance and is embodied in the history of the case; and it seems to be the general rule, subject of course to exceptions, that the record of the child in school has corresponded closely with his behavior outside. Human character is not constructed, like the hold of a great modern ship, with separate, water-tight compartments, so that the vessel will keep afloat and be enabled to proceed on its way even though one or several of the compartments may leak and fill with water, so long as others remain secure; but of elements which are inter-dependent, and each of which is vital to the whole, so that if there is a listing and debasement of the individual on the moral side, it is certain that there will be a general lowering of character and efficiency. If there is immoral, dishonest or other serious misbehavior outside the school, disobedience of parents as a habit or general incorrigability, it is almost certain that there will be very low or failing grades at school.

It would be absurd to try to reform the character of a delinquent boy who was a stranger to the ordinary comforts of life; to whom hunger, cold, neglect, filth, and perhaps cruel abuse were every-day experiences, without first attending to his physical needs; and so it is the primary duty of the court to see that wholesome food, comfortable clothing, and medical attention if necessary, are provided for the child, and that those in whose care he is placed while in detention show towards him a gentle kindness and forbearing patience. Under such conditions and surroundings it will not be difficult, ordinarily, to gain his interest and confidence, and to make a beginning of the task of straightening his behavior and habits and helping him to make a new start. If he is a truant, he should be compelled to go to school, and if his home is unfit, he should be placed where he will be suitably supervised and cared for.

Rewards and penalties are necessary to encourage or restrain human action. Delinquent children, like adults, often arrive at the stage where fear of conse-

quences is the only corrective or restraining influence; and only after an ascendency has been gained by measures of force, will appeals to the higher nature and intelligence prove effective. Just as mild chastisement, such as spanking, or putting to bed, or denial of coveted pleasures, are sometimes the only effective means of subduing and controlling the self-willed, unruly little child, so the suspension of privileges, or the denial of things especially craved or desired, or in extreme cases, moderate corporal punishment, will sometimes be found necessary to bring the adolescent delinquent to a realization that there is a higher authority than his own will, and to which he must submit. Then, and only then, may the work of correction or reformation be undertaken with fair hope of success. Not until the delinquent has been made to recognize and submit to constituted authority will measures of kindness, persuasion, or appeals to the intelligence and the better self be worth the while.

Whether one is dealing with what we term delinquency in a boy or a girl, or crime in an adult, the appeal to the higher nature of the subject (which should embody reflections upon the happy results that naturally ensue upon righteous action) must be in most instances accompanied by a picturing of the disastrous consequences, the pains and sufferings, which will inevitably follow a persistence in the evil course. The child, like the person full grown, will not be corrected merely by appeals to his sense of duty to himself and to his fellows, or of self-respect, or to his natural desire to win and hold the good opinion of others, or to attain material advantages or success, although a portrayal of all these considerations will exercise an important influence. To impress and drive home the admonition, the reverse side of the picture must be presented—the pains and penalties, the disgrace, shame, imprisonment, vagabondage, social ostracism, physical suffering, and finally, the spiritual death which will surely result from continued violation of the Divine law.

Taking a child or a group of children from the custody of parents is the most painful and trying task that a juvenile court judge is required to perform, but hard and burdensome though the duty may be, unless the judge takes that step where the welfare of the child and the conditions, in his conscientious judgment, require it, he utterly fails to measure up to his solemn responsibilities, and as the result both the child and the community suffer.

Since the enactment of the Illinois law of 1899, which was entitled a Law for the Care of Dependent, Neglected and Delinquent Children, more especially, many volumes have been published and innumerable publications of lesser pretensions have been issued, magazine and newspaper articles have appeared, learned and able addresses have been delivered, and thoughtful, earnest discussions at gatherings of social welfare bodies have been had in almost every part of the country, upon the subject of juvenile delinquency and dependency. It might very naturally be supposed, therefore, that definite conclusions had been arrived at as to causes of juvenile delinquency and as to methods of disposing of this most dfficult problem. But from Miss Miriam Van Waters, President of the National Conference of Social Work, and a leader in the field of Juvenile Delinquency, we have this announcement: "No study yet published in this country has satisfied all the requirements of a thorough-going scientific inquiry into child delinquency.

The public at large is unaware of this. There is an unfounded assumption that we have on hand a body of principles, which, if applied, would tend to solve our problem. This is not the case."

In discussions of child delinquency, it seems to me too little emphasis has been put upon the importance of religious teaching and influences in the rearing and training of children, and too little attention given to the absence of such teaching and influences as a cause of delinquency.

During the time that I had charge of the Juvenile Court of Spokane County, we made a survey and analysis of conditions found among children who came before the court during a six-year period. In those six years a total of 5,213 children were involved in recorded cases of juvenile delinquency and dependency. Of these 1,422 were girls and 3,791 were boys. In percentages, 27.3 of the total number were girls and 72.7 were boys. At that time a rough estimate of the child population of school age in Spokane county was 40,000. Of the total of 1,422 girls involved in the recorded cases during the period stated, 102 were recorded as having attended church, and of the 3,791 boys, 259 were recorded as having attended church; or a proportion of 8.2 per cent of boys and 8.8 per cent of girls. How many of the 8.2 per cent of the boys, and of the 8.8 per cent of the girls, were actually regular attendants of a church school or of church services at the time they appeared before the court is hard to say, but we will be liberal if we cut our estimate in half. The conclusion was that in the vast majority of cases religion played no part whatever in the lives of those who came under the jurisdiction of the court, and our figures showed that not more than five per cent of the delinquent children involved in recorded cases had had any systematic religious training.

Indeed, I am skeptical as to the probability of scientific study, or of practice along purely scientific lines, ever solving the problem of adult crime or child delinquency.

In this connection the remarks of the Hon. George W. Wickersham, Chairman of the Federal Crime Commission, formerly Attorney General of the United States, one of the great lawyers and leaders of thought in this country, are well worth preserving and reflecting upon. "It will of course be recognized," says Mr. Wickersham, "that there is no definite ascertainable influence which may be said in itself to cause criminal conduct. Physical and psychological conditions may account for much anti-social conduct. Influences surrounding child life, treatment of a first offender by governmental authority—all enter into the problem." But we may recall the observation of John Wesley, as he looked at a prisoner being led to execution: 'There, but for the grace of God, goes John Wesley;' and I wonder whether appeals to that same divine grace might not be more efficacious than psychiatric analyses.

Science, with all its self-sacrificing devotion, and all its marvelous achievements for the enlightenment, welfare and happiness of mankind, has never yet found the means of soothing an aching heart, or of reclaiming an embittered, despairing soul. Is it believable that psychiatry could have transformed the brutalized, desperate, murderous convict Jean Valjean into the self-denying, saintly Monsieur Madeleine?

In an unpretentious but most scholarly little work entitled "The Formation of Character," by the Reverend

Ernest R. Hull, of the Jesuit Order, residing in India, the author says:

"Morality without tenets is not unlike multiplication without the multiplication table—Nay, it is worse. It is like trying to work multiplication without the knowledge of the properties of number on which multiplication rests. For morality—let us emphasize the point once more—is not simply a de facto conformity to a code of conduct imposed by the collective on the individual will. It is more than this. It is code of conduct imposed by the inherent rightness of things, having duty as its counterpart, and principles as its formulation, conscience as its dictator, and a supreme lawgiver as its ultimate source. Without these characteristics you may talk of utilitarianism, or custom, or convention, or social propriety or what you like; but you cannot talk of morality in any proper sense of the word—and in the sense in which morality is at the present time felt to be so serious a desideratum in our schools."

The present condition of our moral standards has been described as chaotic. In a pamphlet entitled "The Ministry of Laymen—a Plea for Lay Evangelism," by Leon C. Palmer, issued by the Brotherhood of St. Andrew of the United States, are the following impressive observations:

"There is a general breaking down of accepted standards of right and wrong, a rebellion against conventions —even those which have the sanction of racial experience through countless generations—and a casting off of all restraint. Jazz music, cubist art, 'free verse,' and problem novels are expressions in the world of literature and art of the same spirit of revolt.

"The marked increase in crime, especially crimes of violence; the lowering of the average age of criminals until it has been stated (by Judge Cropsey, of the Supreme Court of New York) that 'seventy-five per cent of crimes today are committed by youths under twenty-five years of age'; the steady increase in suicides, especially child-suicides (in four successive years) recently the number of children under fifteen years of age committing suicide ran as follows: 477, 707, 959, 1051; the steady increase in the number of divorces, until now there is an average of one divorce for every seven marriages; the lowered ideal of marriage under the guise of 'trial marriages,' 'free love,' 'soul affinities,' etc., until a prominent juvenile court judge advocates what is virtually polygamy on the installment plan—all these are symptomatic of a decaying moral standard, a breaking down of the very idea of right and wrong, and the substitution for it of the idea of 'free individual expression' which in practice means moral anarchy.

"In Harper's Magazine, for January, 1927, there was a leading article entitled 'Wanted, a Substitute for Righteousness.' It was a tragically pessimistic discussion of the breaking down, not only of accepted standards of right and wrong, but of the very idea of right and wrong today. In it the writer discussed various possible substitutes for the idea of right and wrong. She first discussed and dismissed the idea of prudence—enlightened self-interest—as a substitute for the Divine law of right and wrong (which she claimed has been completely and hopelessly lost in the rising generation). She dismissed that as being so dull, drab and commonplace as to have no effective appeal to the emotional life and the will. Then she considered intelligence, or as we might say, enlightened social interest, and dismissed that because it was admitted that only about six per cent of our population have natural intelligence

enough to appreciate and act upon such motives. She was reduced finally to the ideal of beauty—the determination of conduct by the ideal of what is 'beautiful' or becoming in action, as the only incentive that could be counted on to lead to right conduct today.

"What a tragic confession of moral bankruptcy! What an admission of the inability of the human race to solve moral problems without the aid of religion! Morality without religion is but a broken reed, and religion without a personal God is a hollow mockery of the soul's deepest hunger."

In my opinion, religious instruction is vital in the building of character in a child. It seeks to inculcate truth, integrity, chastity, self-restraint, self-denial, kindness, responsibiliy, ambition, and useful effort; and what could be more essential in the life of an individual than these virtues? But teaching, whether in church or at home, is not enough. It must be accompanied by right example on the part of the parents or of those responsible for the rearing of the child—conduct in daily life which reflects faithful endeavor to carry on according to precept.

"Fox Fire" or Phosphorescence on Rotted Wood

The forester, woodsman or casual visitor in the forest often encounters at night a phenomenon which is both awe-inspiring and interesting. This phenomenon is expressed by a bright phosporescent glow or "fox fire" as it is commonly called which is visible at night on certain old rotten stumps, logs or pieces of wood. One woodsman has referred to it as "streaks of radium" in an old stump. Several "old timers" have been startled at rare times by witnessing some forest animal, its fur coat shining with "fox fire" issueing from a rotten, hollow log.

The phenomenon in question is fairly common on rotted wood where the fungi or bacteria responsible for it find sufficient food and proper moisture and oxygen conditions for their development. Certain fungi which cause decay in wood are capable of producing this phosphorescent glow at night. Many bacteria are also found producing a similar effect on decaying wood, and on decomposing animal or vegetable matter in general. The effect is often noted upon the surface of water and is common on the surface of the ocean in certain regions. The luminosity exhibited by some insects and deep sea fishes is closely related.

The glow or light emitted is believed to be due to the slow oxidation of certain elements within the cells of the organisms. This slow burning of oxygen produces a phosphorescent glow which varies in color and intensity with the organism producing it. Experiments, conducted by various scientists, indicate that the light-producing bacteria are incapable of producing light in the absence of oxygen.

—E. E. Hubert

Stand Tables for Second-Growth Western White Pine[1]

By I. T. Haig
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JUST as any timberland owner or forest manager is financially interested in knowing the timber volume a given tract of forest land will produce so he is interested also in knowing the size of trees in which this volume will be found. For example, the owner interested chiefly in sawlog timber has learned that it is much more expensive to log and mill a given volume in small trees than an equal volume in large, and realizes that as a result the general run of trees by diameter directly affects the financial outcome of his operation. The small owner, interested perhaps more closely in post and tie production, is also definitely concerned in knowing how many trees will be large enough to yield these products at various ages and perhaps in learning about how many trees of suitable size he can remove for posts and ties and still leave enough trees to produce a cut of sawlog timber at a later date. In these and similar ways the range of trees in diameter and the number of trees of various diameters are matters of considerable interest and importance to the forest manager.

Almost all yield tables have attempted to furnish some information on tree distribution by including tables showing the total number of trees above one or two selected diameter limits and the average size of tree at various age-site conditions. But few yield tables published previous to 1926 made any pretense of including adequate stand tables showing for all age-site conditions the number or percentage of trees and volume in each diameter class and above various diameter limits. It is the purpose of this article to present such stand tables for the western white pine type.

The lack of adequate stand tables in the past has been due not so much to any failure to realize their desirability as to obvious difficulties in their construction and presentation. Few investigators gathered enough data in more than one or two age-site classes to prepare reliable stand tables; the run of trees on adjacent sites and ages show marked inconsistencies making it difficult to construct tables by cross curving; and at best, the final tables, in any set adequately covering all age-site conditions, would have been so numerous as to be difficult of presentation. For example about forty-eight stand tables of tree distribution alone would have been necessary in the western white pine type.

About 1923, however, this problem was attacked with commendable originality by F. S. Baker (1) who demonstrated that the distribution of trees in even-aged stands of aspen follows very closely the Gaussian law of normal frequency distribution and that hence trees are grouped about the average diameter in a regular, predictable fashion. Bruce (2) followed this lead with an analysis of tree distribution in the four principal species of southern yellow pine facilitating the analysis by the use of frequency co-ordinate or probability paper on which the bell-shaped normal frequency curves employed by Baker become straight lines when values are expressed in cumulative percentages. One fundamental discovery developed in this work was that tree distribution

[1]Presented at the Annual Meeting of the Northwest Scientific Association, December, 1930, Spokane, Washington.

is a function of average diameter rather than age and site[2] and that in stands of a given average diameter trees are distributed in a regular and consistent fashion regardless of variations in age and site conditions. This discovery enabled the presentation of stand tables for one species in a single graph or table showing for stands of given average diameter the percentage of trees in each diameter class. This method as first evolved was rather limited in application as it could be used only with species whose frequency distributions followed the handling very complex frequency distributions[3] and so flexible that it can be used not only with distribution of number of trees but with distributions of basal area and cubic volume as well.

The stand tables presented in this article for number of trees, basal area and cubic volume (Tables I, II, and III, respectively) were all read from alinement charts constructed by Bruce and Reineke's method. The stand table for board foot, Table IV, was first constructed graphically by a series of harmonized frequency curves. This table could not be built in alinement

TABLE I.—Distribution of trees above various diameter limits; all species combined.

Lower Diameter Class	Average Diameter Entire Stand—Inches																
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Percentage of All Trees in and above Lower Diameter Class.																
Inches	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	100	100	100	100	100	100	100	100	100	100	100	100	100				
2	56	75	84	87	89	90	92	92	93	94	96	98	99				
3	8	42	62	72	77	81	83	85	87	89	92	95	98	99			
4		16	42	56	65	71	75	78	81	83	86	91	95	98			
5		4	24	42	53	61	67	71	75	78	81	86	91	96	99		
6			12	28	43	53	59	65	69	73	76	81	86	92	96	99	
7			5	18	33	44	52	58	63	67	71	76	82	87	93	96	99
8			2	10	23	35	44	51	57	62	66	71	77	82	88	93	96
9				5	15	26	36	44	50	56	60	66	71	77	83	87	92
10					9	19	28	37	44	50	55	61	66	72	77	82	87
11					5	13	22	31	38	44	50	55	61	66	72	77	82
12						9	16	24	32	39	44	50	56	61	67	72	76
13						5	11	19	26	33	38	44	50	55	61	66	70
14							8	14	20	27	33	39	44	49	55	60	64
15							5	10	16	22	27	33	38	44	49	54	58
16								6	12	17	22	27	33	37	43	47	51
17									8	13	17	22	26	31	36	41	45
18									5	9	13	17	21	25	30	34	38
19										6	10	13	16	20	24	28	31
20											7	10	12	15	19	22	25
21											5	7	9	11	14	17	19
22												5	6	8	10	13	15
23														6	7	9	11
24															5	6	8
25																	5

normal trend or whose skewness of distribution was such that it could be corrected by the use of logarithmic frequency paper. Bruce and Reineke (3) finally solved this difficulty by developing an alinement chart method of constructing stand tables capable of chart form since the rigid lower merchantibility limit distorts the tree distribution of stands of smaller d. b. h. without affecting those of the larger and causes skewed distributions of a character that cannot be handled by the alinement chart method. The final table, however, is of about equal accuracy. These tables all show values in cumulative percent, i.e., the percentage of total trees, basal area or volume in and above any chosen lower diameter class. Perhaps the most striking thing

[2]It is interesting to note that this same discovery seems to have been made independently by a Russian investigator, A. Tarashkev'th. *The Composition of Pure Stands*. Collection of works on forestry, Leningrad Agricultural Institute, p. 106-135, 1926.

[3]Some investigators have used Charlier's Tables in stand table construction when the frequency distributions are abnormal.

TABLE II.—Distribution of basal area above various diameter limits; all species combined

Lower Diameter Class	Average Diameter Entire Stand — Inches																		
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Percentage of Total Basal Area in and above Lower Diameter Class																		
Inches	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	100	100	100	100															
2	95	96	97	98															
3	78	88	93	96	97														
4	49	73	84	91	94	96	98												
5	20	52	72	83	89	93	95	97	98										
6	7	32	57	73	82	88	92	95	96	98									
7		17	39	60	72	81	87	91	94	96	97								
8		8	25	46	62	73	81	87	91	94	96	97	98						
9		3	15	32	50	63	73	80	85	90	93	95	97	98					
10			8	20	38	50	62	72	79	85	89	92	94	96	98				
11			4	13	25	39	52	63	72	79	84	88	91	94	96	97			
12				8	17	29	42	54	63	72	78	83	88	91	94	96	97	98	
13				5	11	20	32	44	54	65	72	78	83	88	91	93	95	97	98
14				2	8	15	24	34	45	56	64	71	78	83	88	91	93	95	97
15					5	10	18	27	37	48	57	65	72	79	84	88	91	93	95
16					3	7	13	21	29	40	49	58	66	73	79	83	87	91	93
17						4	9	15	22	32	40	49	58	66	73	78	83	87	91
18						3	6	11	16	22	32	40	49	58	66	72	78	83	87
19							3	7	11	18	24	32	40	50	58	65	71	77	82
20							2	5	8	13	18	22	32	41	50	57	64	71	77
21								3	5	9	13	18	24	32	40	47	55	62	70
22									3	6	9	13	18	22	32	38	46	54	62
23										4	6	9	13	17	23	29	36	44	52
24										2	4	6	9	12	17	22	28	34	42
25											2	4	6	9	12	16	20	26	32
26												2	4	6	9	11	15	19	24
27														3	5	8	10	14	18
28															3	5	7	9	13
29																3	5	7	9
30																	3	4	6

TABLE III.—Distribution of cubic-foot volume above various diameter limits; all species combined.

Lower Diameter Class	Average Diameter Entire Stand — Inches																		
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Percentage of Total Cubic-Foot Volume in and above Lower Diameter Class																		
Inches	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	100	100	100																
2	98	98	99																
3	82	93	96	98															
4	54	81	91	95	98														
5	26	64	82	90	95	97													
6	9	44	70	82	89	93	97												
7	2	26	54	72	82	89	94	96	98										
8		13	37	58	73	82	89	93	96	97									
9		5	24	42	60	72	82	88	92	95	97								
10		2	14	31	48	63	74	82	88	92	94	96	98						
11			7	20	34	50	64	74	81	87	91	94	96	98					
12			3	12	24	38	53	64	74	80	86	90	93	95	97				
13				7	16	28	42	54	64	73	79	86	89	93	95	97			
14				3	10	20	32	43	55	64	72	79	85	89	92	95	97	98	
15					6	13	23	33	44	54	64	72	78	84	88	92	94	96	98
16					3	9	17	26	36	45	55	64	72	78	84	88	92	94	96
17						5	11	18	27	36	46	55	63	71	77	83	88	91	94
18						2	7	13	20	28	36	46	52	64	71	77	82	87	91
19							4	8	14	20	28	36	45	52	62	70	76	82	86
20							2	5	9	15	21	28	36	46	52	62	69	76	81
21								3	6	9	15	20	28	36	42	52	60	68	74
22									3	6	10	15	21	28	36	44	52	60	68
23									2	4	7	11	16	22	28	35	43	51	59
24										2	4	7	10	15	20	27	34	42	50
25											2	4	7	11	15	20	26	34	41
26												2	4	7	10	15	20	25	32
27													2	3	6	9	13	18	23
28														2	3	5	8	12	16
29															2	3	5	8	11
30																2	3	4	6

which they illustrate is the unusually small size of trees in fully stocked western white pine stands. For example in 120-yead old stands on good site (site index 60) almost half the trees (49 percent) are 10 inches and under in diameter; on poor sites (site index 40) at this same age, 81 per cent of the trees are 10 inches and under; even on excellent site (site index 70) 30 per cent are 10 inches and under. But although only 51 per cent of all trees are over 10 inches in diameter at 120 years on good site, the stand tables show that these trees contain some 92 percent of the total cubic and 93 per cent of the total board-foot volume. By supplying such illuminating values stand tables make an excellent supplement to yield tables proper and give a far more detailed and satisfactory picture of the stand than a mere statement as to the total number of trees or volume per acre at various age-site conditions.

TABLE IV.—Distribution of board-foot volume above various diameter limits; all species combined

Lower Diameter Class	Average Diameter Entire Stand — Inches																
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Percentage of Total Board-Foot Volume in and above Lower Diameter Class																
Inches	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
7	100	100	100	100	100	100	100										
8	37	69	83	89	94	97	98										
9	9	32	58	72	83	89	92	94	97	98							
10	3	14	35	53	67	77	84	89	93	94	97	98					
11		6	19	35	50	64	74	81	86	91	93	95	97	98			
12		3	10	21	36	50	61	71	78	84	89	92	94	96	97	98	
13			5	13	24	36	49	60	69	76	83	87	91	93	95	96	97
14			3	7	15	25	37	48	58	68	75	81	86	90	93	94	96
15				4	9	16	26	36	47	57	67	74	80	85	89	92	94
16				3	5	11	19	27	37	47	57	65	72	80	84	88	91
17					3	7	12	19	28	37	47	56	65	72	79	84	87
18					2	4	8	14	20	29	38	47	55	65	72	78	83
19						3	5	9	14	21	29	37	46	56	65	71	77
20							3	6	9	15	21	29	38	47	56	65	71
21							2	4	6	10	15	21	29	38	47	56	64
22								3	4	7	11	16	22	29	39	47	56
23									3	4	7	11	15	21	30	39	46
24										3	4	7	11	15	21	30	37
25											3	4	7	10	14	21	28
26												3	4	6	8	14	20
27													3	4	5	8	14

ent by diameter class. Table V shows by 5-inch diameter groups tree distribution in average fully stocked stands on good sites (site index 60) at 120 years.

TABLE V.

Stand table showing distribution of trees in a fully stocked 120-year old stand on good site (site index 60).

Diameter breast high	Distribution of trees by diameter class	
Inches	Percent	Number
1-5	23	90
6-10	26	101
11-15	28	109
16-20	18	70
21-25	5	20

These values are derived by first computing from Table I the percentage in each diameter class for a stand of 12.2

inches average diameter (the yield table value for stands on site index 60 at 120 years) and multiplying this by 390, the average number of trees in fully stocked stands of that age-site condition. In building up tables for natural stands actual stand values, not yield table values, should be used.

The tables given are only directly applicable to fully stocked stands of average composition. They should, however, furnish satisfactory approximations of the distribution of trees and volumes in stands approaching full stocking, a condition fairly common in second-growth western white pine in which well stocked stands run about 70 per cent of normal (4) and in which a good share of the understocking is due to small holes entirely bare of trees thus causing the stocked area to average in density even closer to normal. Composition, of course, also affects tree distribution, tolerant species tending to concentrate in the smaller diameter classes and intolerant in the larger. Thus the tables herein presented tend to underestimate the number of small trees in stands running heavily to hemlock and cedar and overestimate the number of large trees. But errors of this sort can be eliminated, for number of tree values at least, by the use of tables showing the distribution of individual species (5). Due to the inconsistencies introduced by variation in composition and stocking, however, the stand tables herein presented must be considered for the most part as furnishing approximate values only. But lacking more precise information they should furnish information of interest and value to all owners of second-growth western white pine timber interested in forest management. This information has never before been available.

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Tribute To An Inland Empire Scientist

Just tribute to a great scientist and agriculturist was paid recently when a memorial service was held at Washington State College for the late Dr. W. J. Spillman.

In the group that gathered on October 22, 1931 to honor his memory there were present representatives from the University of Idaho, United States Department of Agriculture, Northwest Scientific Association, Washington State Grange, Farm Bureau and Farmer's Union, agriculture press and chambers of commerce, as well as faculty and students of Washington State College.

Dr. E. O. Holland, president of the college, presided. He read several messages of tribute, including those from Arthur M. Hyde, secretary of the United State Department of Agriculture; Walter Williams, president of the University of Missouri, where Dr. Spillman received his college training, and Arthur H. Jenkins, editor of the Farm Journal, of which Dr. Spillman was one time coeditor.

The early career of Dr. Spillman was outlined by Dr. E. A. Bryan, president-emeritus of Washington State College, who said it was at Pullman, Washington that Dr. Spillman began his career as an agriculturist and did his first great work, the rediscovery of Mendel's law of plant breeding and the first publication of it in English.

Dr. Spillman's connection with the United States Department of Agriculture was told by Professor Rex Willard, head of the Farm Management Department at W.S.C., who said Dr. Spillman developed the federal system of extension work. E. A. Smith, editof the Pacific Northwest Farm Trio, also spoke.

Dr. Spillman, who died last July, began his work as a scientist in agriculture in 1894. He became head of the College of Agriculture and director of the Experiment Station at Washington State College from which position he went to the United States Department of Agriculture in 1902 where he remained almost until his death. It was his urgent wish that his ashes might rest on the self same plots where his discoveries in heredity were made.

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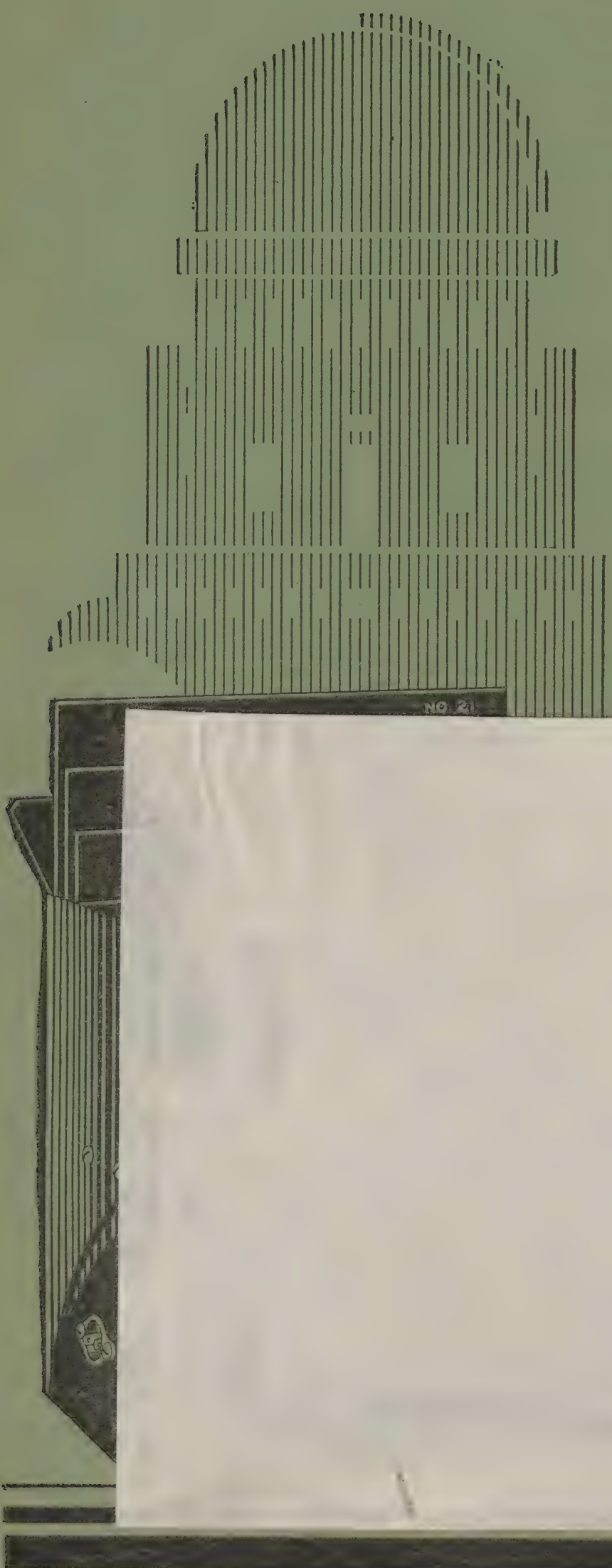
UNIT NO. 19

Constellations

and

Star Study



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